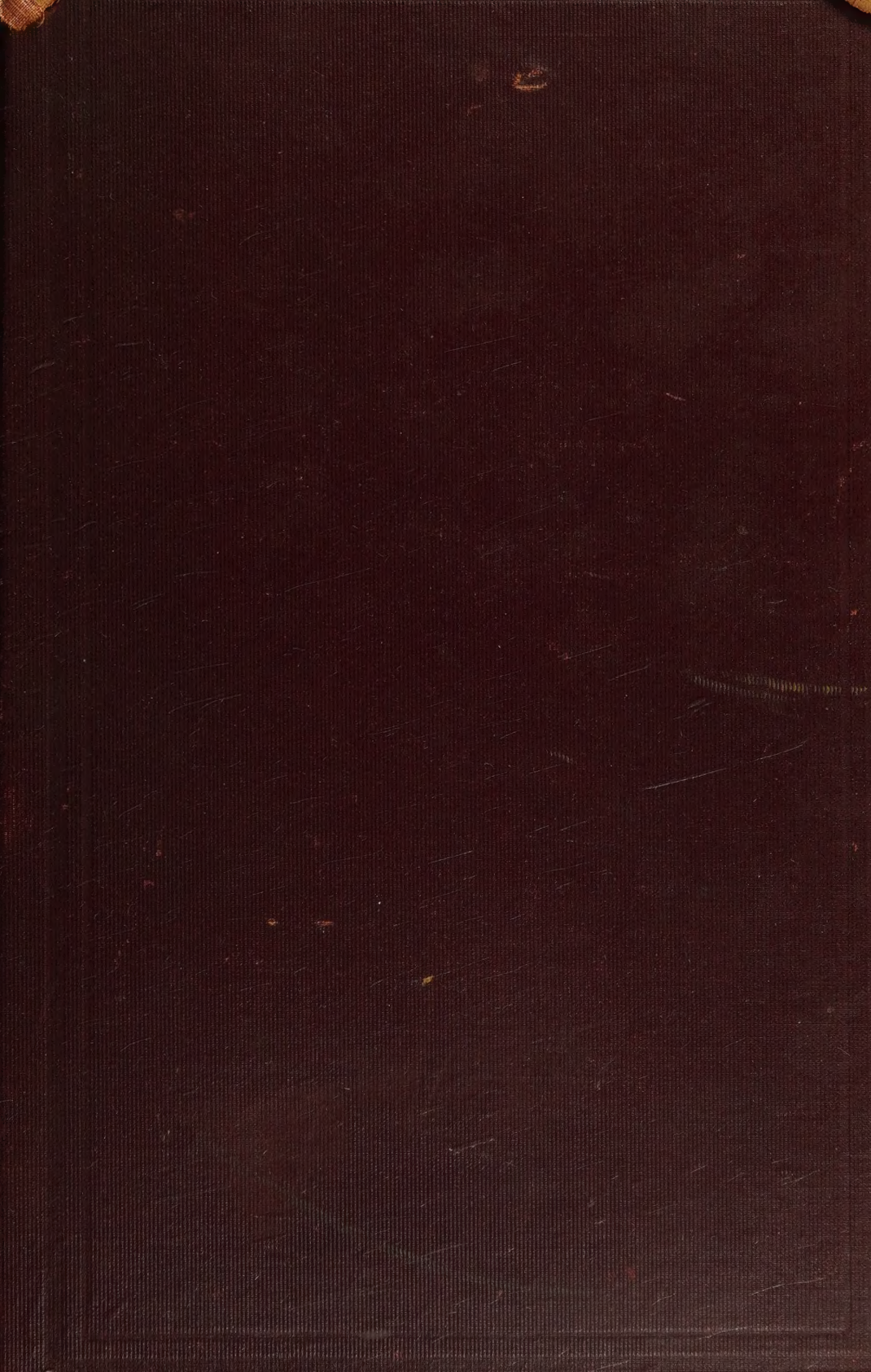






THE OPERATIONS OF SURGERY

THE OPERATIONS OF SURGERY

INTENDED ESPECIALLY FOR THE USE OF THOSE
RECENTLY APPOINTED ON A HOSPITAL STAFF

AND FOR

THOSE PREPARING FOR THE HIGHER EXAMINATIONS

BY

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SURGERY IN THE MEDICAL SCHOOL

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PART IV.

THE ABDOMEN.

CHAPTER I.

LIGATURE OF VESSELS.

EXTERNAL ILIAC. COMMON ILIAC. INTERNAL ILIAC.
GLUTEAL. SCIATIC. ABDOMINAL AORTA.

LIGATURE OF THE EXTERNAL ILIAC (Figs. 1, 2, and 3).

Indications.—Chiefly :

1. Some cases of aneurysm of the upper part of the femoral, or of the femoral encroaching on the external iliac itself.—Mr. Holmes (R.C.S. Lect., *Lancet*, 1873, vol. i.) shows that in ilio-femoral aneurysms it is often very difficult to say whether the aneurysm is or is not limited to the iliac or femoral—*i.e.*, whether it is wholly above or below the place where the deep epigastric and circumflex iliac come off, or whether the mouths of these vessels open out of the sac. In the former case the aneurysm would be purely iliac or femoral; in the latter, ilio-femoral. Thus, ligature of this vessel is indicated where pressure, rapid or gradual, has failed to command the circulation, where it is intolerable, where it cannot be made use of owing to the abundance of fat, from failure of pulse and breathing under an anæsthetic, or from the height at which the aneurysm involves the external iliac (it being increasingly difficult to apply pressure in these cases without dangerous interference with the peritonæum and its contents), where the patient from chronic bronchitis is quite unfit for a prolonged trial of continuous pressure under an anæsthetic, or in cases where the increase of the aneurysm is very rapid.

Before deciding on relinquishing the idea of pressure for ligature, the surgeon should refer to a paper by Mr. Wheelhouse (*Clin. Soc. Trans.*, vol. vii. p. 57). This case is one of the most interesting in all surgery.

The patient, a publican, and syphilitic, had previously been cured by Mr. Wheelhouse of a right-sided popliteal aneurysm,* by means of continuous pressure for eight hours

* It is very possible that the strain thrown on the artery above during the treatment by pressure on the femoral was the cause of the aneurysm higher up. The liability of

with a Porter's femoral-compressor. A few months later he was admitted into the Leeds Infirmary with a large right iliac aneurysm,* reaching from Poupart's ligament to within two inches of the umbilicus, and extending outwards almost to the spine of the ilium. The swelling, about the size of a small cocoa-nut, was hard and firm below, soft above; it appeared to be wholly connected with the external iliac, but to extend above and overlie the common iliac. Pressure could not be made on the latter vessel sufficient to stop the beating, as the tumour was too much in the way, but it was easily controlled by pressure on the abdominal aorta. The patient was kept under the influence of ether for five hours, Lister's tourniquet being very slowly screwed down just over the umbilicus. By the end of the time the patient was black in both limbs, and blue as far as the tourniquet. This had been slightly relaxed twice. No other unpleasant symptom arose during the whole time. A quarter of an hour was taken in relaxing the pressure—a quarter turn of the handle being made every minute. The tumour had ceased to pulsate, and was firm and hard. Pulsation gradually recurred with nearly its old force, but was less “distensile,” and slowly ceased altogether, an excellent recovery being made.†

In ruptured femoral aneurysm the old operation (facilitated by the application of a tourniquet above) would usually be indicated, but Mr. Southam (*Brit. Med. Journ.*, 1883, vol. i. p. 818) has briefly reported a case in which he tied the external iliac successfully in a patient whose femoral aneurysm suddenly ruptured and became diffuse. The effused blood was quickly absorbed, and there was never any tendency to gangrene. Complete power over the limb was regained.

patients with one aneurysm to develop another may often baffle the surgeon. Mr. Clutton (*Brit. Med. Journ.*, 1880, vol. i. p. 441) records a case in which a femoral aneurysm was cured by the use of Esmarch's bandage applied up to the tumour, and a Pétit's tourniquet adjusted over the brim of the pelvis. The first attempt lasted an hour; at the second trial the bandage was removed in an hour, and the tourniquet continued for nine hours, anæsthetics not being given. The aneurysm ceased to pulsate and began to shrink, but still fluctuated. Nine days after leaving the hospital, the patient died suddenly of an aortic aneurysm rupturing into the pericardium.

* Dr. Diver, of Southsea, has put on record a case in which the external iliac was tied in a case in which a popliteal and an inguinal aneurysm co-existed on the right side. Gangrene followed, a line of demarcation forming in the lower third of the leg. Amputation through the thigh was performed, and the patient recovered. A similar case of double aneurysm is reported by Mr. Hilton (*Med.-Chir. Trans.*, vol. lii. p. 309). A tourniquet was first applied to the right common iliac for six hours without effect on the aneurysms. A second trial of pressure was made later on, with a tourniquet again on the common iliac and one on the femoral at the apex of Scarpa's triangle. In about nine hours both aneurysms were cured. Chloroform was used on both occasions.

† Cases of Dr. Mapother's and Mr. Holden's, in which ilio-femoral aneurysms were cured by pressure on the common iliac and the aorta, will be found recorded by Dr. Mapother in the *Dab. Med. Press*, March 29, 1865; and by Mr. Holden in *St. Barthol. Hosp. Rep.*, vol. ii. p. 190; *Syd. Soc. Bien. Retr.*, 1865-6, pp. 305, 307. In Dr. Mapother's case, instrumental pressure on the right common iliac (about an inch below and half an inch to the right side of the umbilicus), kept up for twelve hours under chloroform, had failed. A second attempt, with a Signorini's tourniquet on the end of the abdominal aorta, and a Skey's tourniquet on the femoral just as it left the sac, pressure being kept up for four hours and a half, made the tumour solid and pulseless. Two rigors followed, and a carbuncle formed at the site of the first compression. In Mr. Holden's patient the aneurysm was also large, and double aortic valvular disease was present. Chloroform was given here continuously for an hour and a half, and then with cautious intermissions, owing to the state of the pulse and breathing, for the rest of the treatment, which lasted four hours.

2. Wounds.—A wound of the external iliac is very rare.* Mr. Pringle (*Scottish Med. and Surg. Journ.*, Oct. 1901), has successfully sutured a wound of the external iliac. The opening was $\frac{1}{4}$ inch long and was sewn up with catgut, which produced a kink in the artery, but no leakage took place, and six months later the man was quite well and able to work. The deep circumflex iliac artery was tied, because it originated $\frac{1}{4}$ of an inch below the incision in the artery. During the operation bleeding was prevented by pressure on the abdominal aorta. This brilliant result adds another reason for opening the wound and seeking the bleeding spot in all cases of hæmorrhage from a wound near large vessels. It has been frequently tied for hæmorrhage from parts below—*e.g.*, for secondary hæmorrhage after wounds of the femoral high up, after ligature of the femoral, and after amputation at or near the hip. The futility† of this treatment is thus shown:

Dr. Otis (*Med. and Surg. History of the War of the Rebellion*, pt. iii. p. 788) gives a summary of twenty-six cases in which the external iliac was tied for such cases as the above. Of these, twenty-three ended fatally, a mortality of 88·4 per cent. The uselessness of trusting to ligature of the external iliac in such cases, instead of either securing the wounded vessel itself, or trusting to well-applied pressure, was long before this insisted on by Guthrie.‡ This question is alluded to again below, but in proof of the above statement a case may be mentioned here, in which hæmorrhage returned after ligature of the external iliac, and was arrested by well-applied pressure. The patient had been wounded, January 15, 1865, by a minié ball, entering at the upper and inner part of the thigh, and emerging near the knee. The wound becoming sloughy, hæmorrhage occurred (March 23 and 31), and the external iliac was tied. April 21, hæmorrhage recurred from the upper gunshot wound, and was successfully restrained by a horseshoe tourniquet, constantly kept on for two weeks, when it was omitted, without any subsequent hæmorrhage. The wounds were now healing kindly, when (May 31) dysentery set in, carrying off the patient, June 15, two and a half months after the operation of ligature.

3. Elephantiasis.—Ligature of the external iliac or femoral (when the condition of the soft parts admits of it) has been extolled by some surgeons in the treatment of this affection.§ A larger experience shows,

* The only case with which I am acquainted is one quoted by Mr. Erichsen from Velpeau (*Nouv. Elém. de Méd. Opér.*, t. i. p. 175), in which the above French surgeon was suddenly called upon to tie the external iliac for a knife-wound. Though there had been no preliminary dilatation of the collateral circulation either by pressure or by the presence of an aneurysm, the result was successful.

† It is fair to state that Mr. Bartleet, of Birmingham, published a case in which the external iliac was tied successfully after secondary hæmorrhage from the common femoral, the latter having been tied for aneurysm of the femoral artery. Previous to ligature of the external iliac, "sponge-pressure" and pressure by means of a Martin's bandage were tried, but no details are given. It is noteworthy that the catgut ligature applied to the femoral in this case came away on the seventh day (the first day of the hæmorrhage) unobserved, and surrounding a small slough of the artery. It had been tied "tightly."

‡ *Wounds and Injuries of the Arteries*, Lects. v. and vi.

§ An apparently successful case is reported by Mr. Leonard, of Bristol. Measurements are given nearly three years after the operation, showing that the success was then maintained. Five years later the patient reported that "his leg was much the same" as at the last report. Bandaging does not appear to have been made use of here. Prof. Buchanan (*Brit. Med. Journ.*, Nov. 23, 1867; *Syd. Soc. Bien. Retr.*, 1867-8, p. 300) reports a case, seven months after the operation, apparently cured by ligature of the external iliac, after failure of rest and methodical compression (this was before the introduction of Martin's bandage). Three months later it is candidly stated that the disease had

however, that when cases thus treated are watched, the cures cannot be relied upon as permanent. Moreover, too little value has been attached, in reported cures by ligature of the main vessel, to the thorough rest and elevated position entailed by tying the artery.

This operation should, I think, be reserved for those cases (which will be very few) in which Martin's bandages cannot be applied, owing to cracks, foul ulcers, or burrowing sinuses. Here the ligature may be used after explaining its risks to the patient, but only as a subsidiary measure. The bandage will have to be used as well later, and persisted in, during the day at least, probably for life.

4. As a distal operation in aneurysm of the common iliac.—Ligature of the external iliac has been so unsuccessful here as to call for no further comment.

Surgical Anatomy.

EXTENT.—From the lumbo-sacral articulation to a point just internal to the centre of Poupart's ligament. LENGTH— $3\frac{1}{2}$ to 4 inches.

SURFACE MARKING.—From a point an inch below and to the left of the umbilicus to a point just internal to the centre of Poupart's ligament.

RELATIONS :—

IN FRONT.

Peritonæum, small intestines.

Iliac fascia.

Lymphatic glands and vessels.

Genito-crural nerve (genital branch).

Spermatic vessels

Circumflex iliac vein

} Crossing artery near Poupart's
ligament.

OUTER SIDE.

Psoas (above).

Iliac fascia.

External iliac
artery.

INNER SIDE.

Iliac fascia.
Vein.

BEHIND.

Iliac fascia.

Vein (above).

Psoas (below).

Vas deferens (dipping
from internal ring
to pelvis).

Collateral Circulation.

Deep epigastric	with	Internal mammary, lower intercostals, and lumbar.
Deep circumflex iliac	„	Ilio-lumbar, lumbar, and gluteal.
Gluteal and sciatic	„	Internal and external circumflex.
Comes nervi ischiadici	„	Perforating branches of profunda.
Obturator	„	Circumflex arteries and epigastric.
Internal pudic	„	External pudic.

recurred to a considerable degree. Dr. White, of Harvard University (*Internat. Encycl. of Surg.*, vol. ii. p. 631), quotes Wernher (reference not given) as having followed up thirty-two cases; in all there was an immediate reduction of size, but the relief was permanent in three only. Dr. Pinnoch, of Melbourne (*Lancet*, 1879. vol. i. p. 44), gives a case in which no permanent benefit followed on ligature of the femoral artery.

Operation.—(1) By the lower and more transverse incision of Sir A. Cooper. (2) By the muscle slitting extra-peritonæal method. (3) By the higher and more vertical incision of Abernethy. The two are compared at p. 8. (4) By the intra-peritonæal method (p. 22).

(1) **INCISION OF SIR A. COOPER.**—This is the method more frequently made use of. The diet having been limited, and the bowels having been freely moved for some days before the operation, the parts shaved, and the hip slightly* flexed, an incision is made 4 inches long ($4\frac{1}{2}$ to 5, if there be very much fat, or if the parts are pushed up by a contiguous aneurysm), parallel with Poupart's ligament, and nearly an inch above it, commencing just outside the centre of the ligament and extending outwards and upwards beyond the anterior superior spine.† The superficial fascia and fat, varying in amount, being divided, and the superficial circumflex iliac vessels secured, the external oblique, both fleshy and aponeurotic, is cut through, and then the fleshy fibres of the internal oblique and transversalis. This is done either by using the knife alone, lightly and carefully, or by taking up each layer with forceps, nicking it, and slitting it up on a director. If the wound be sponged carefully,‡ a layer of cellular tissue can usually be seen between the muscles, however thin they are. Any muscular branches should be secured with Spencer Wells's forceps as soon as cut; and in pushing a director beneath the muscles as little damage as possible should be done, owing to the proneness to cellulitis later on, and to the proximity, in a thin patient, of the peritonæum. The fascia transversalis, when exposed, will be found to vary a good deal in thickness and in the amount of fat which it contains. It is to be divided very carefully,§ and the extra-peritonæal fat, if present, will next come into view. First one and then two fingers being introduced, the peritonæum is to be gently stripped up from the iliac fossa towards the middle line—i.e., upwards and inwards as far as the inner border of the psoas. In

* So that the skin may not be too much relaxed before being incised. Later on, to relax the parts, the hips may be more strongly flexed.

† The incision may have to be made higher than usual, owing to the upward extension of the aneurysm, to enable the surgeon to tie either the upper part of the external or the common iliac. On this point see the remarks on the comparison of Cooper's and Abernethy's operations, p. 8. Often in these cases of upward extension of the aneurysm the sac is found to involve the lower part of the artery, and to have overlapped the upper portion.

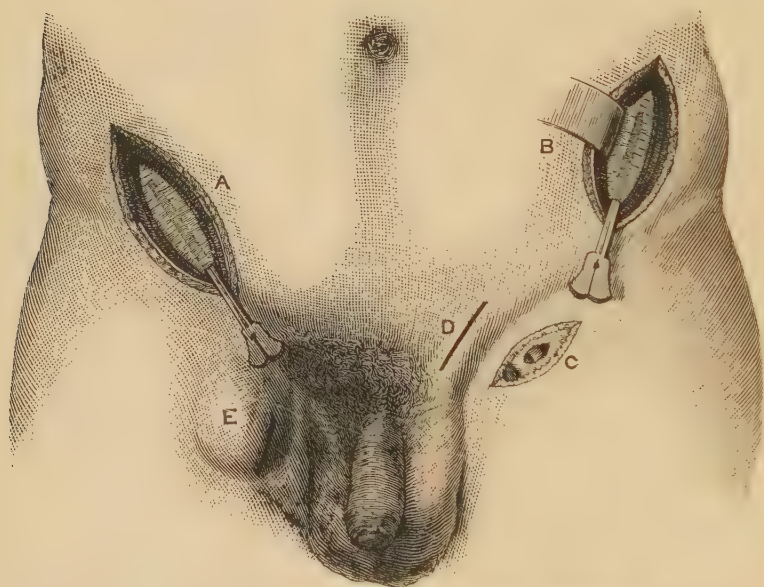
‡ In some cases where the circulation has been much interfered with by an aneurysm, most copious hæmorrhage, especially venous, has been met with in the earlier steps of this operation.

§ Dr. Sheen (*Brit. Med. Journ.*, 1882, vol. ii. p. 720) thus writes of the accident which may happen here: "I made the incision somewhat too high, and, in consequence, opened the peritonæum, which I mistook for transversalis fascia. Even then I was in a little doubt, because some (omental) fat presented itself, which very much resembled the fat seen in the previous case (fat around the vessel), but, in pushing this up gently, a knuckle of bowel came into view, which settled the matter." The wound in the peritonæum was sewn up with two fine carbolised sutures, and the case did perfectly well.

|| Great care is needed here if the peritonæum be adherent. This condition, when present, is usually found above. It is especially likely in long-standing cases, and where the aneurysm has caused irritative and inflammatory changes. By some it is held that the transversalis fascia can always be stripped up along with the peritonæum. As this fascia is thickened and attached, close to Poupart's ligament, to form the deeper crural arch and

doing this care must be taken, especially in the dead body, not to separate the iliac fascia and the vessels from their position on the psoas, not to tear this muscle, and not to lacerate the peritonæum. As soon as the peritonæum has been well raised, an assistant keeps this and the upper lip of the wound well out of the way by means of broad retractors. The surgeon then feels for the pulsation of the artery on the inner border of the psoas, and carefully opens the layer of fascia which ties the vessel to the psoas, and forms a weak sheath to it. This should be done $1\frac{1}{4}$ inch above Poupart's ligament, so as to lie well above the origin of the deep epigastric, which usually comes off $\frac{1}{4}$ or $\frac{1}{2}$ inch above Poupart's ligament, and the needle passed from

FIG. 1.



To show the incisions for—A, Ligature of the external iliac artery. B, Ligature of the common iliac artery. C, Ligature of the common femoral artery. D, Strangulated inguinal hernia. E, Strangulated femoral hernia. (Heath.)

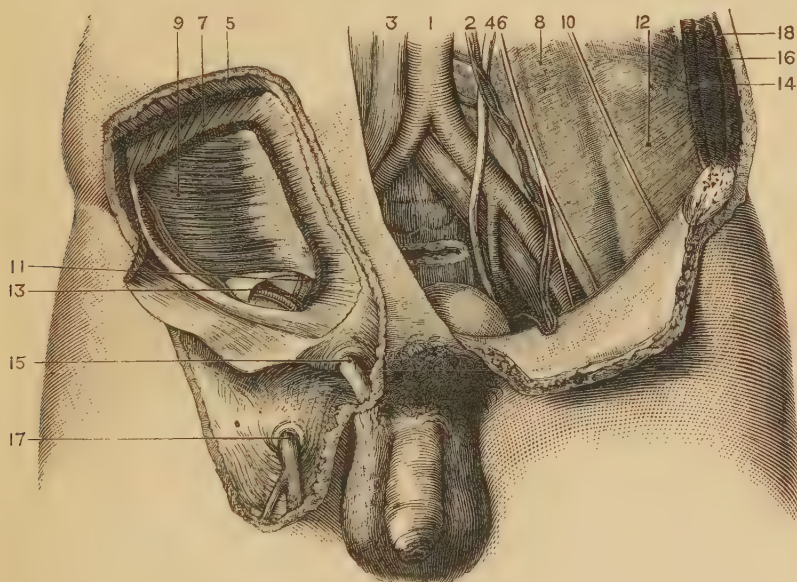
within outwards, carefully avoiding the vein on the inner side and the genito-crural nerve outside and in front. In difficult cases the ligature (of sterilised silk, or kangaroo-tail) must mainly be passed by touch, but a free incision, adequate use of retractors, and light thrown in by a large mirror will usually allow the surgeon to see what he is doing. The effect of tightening the ligature being satisfactory, it is cut short and dropped in, the divided muscles are then brought together with buried catgut sutures, and the superficial wound closed. The parts must be kept relaxed by propping the chest up slightly and flexing the knees over a pillow, but too much flexion of the groin is to be deprecated as causing a deep sulcus from which possible discharges may

front of the femoral sheath, it is very doubtful if it can ever be detached unless it be divided or torn through. The latter is very easy on an aged corpse.

escape with difficulty. The limb is evenly bandaged from the toes upwards, raised, and kept covered in cotton-wool, with hot bottles placed in the bed.* In case of threatening gangrene, assistants should persevere in a trial of friction of the limb from below upwards. Where there is a history of syphilis, appropriate remedies should be given after the operation.

(2) After slitting the external oblique as described under Cooper's operation, the fibres of the internal oblique and transversalis muscles

FIG. 2.



Anatomy of the iliac arteries and hernia.

- | | |
|-------------------------|-----------------------------------|
| 1. Abdominal aorta. | 10. External cutaneous nerve. |
| 2. Spermatic vessels. | 11. Epigastric vessels. |
| 3. Inferior vena cava. | 12. Iliac fascia. |
| 4. Ureter. | 13. Spermatic cord. |
| 5. Obliquus externus. | 14. Section of transversalis. |
| 6. Genito-crural nerve. | 15. External abdominal ring. |
| 7. Obliquus internus. | 16. Section of obliquus internus. |
| 8. Psoas fascia. | 17. Saphenous opening. |
| 9. Transversalis. | 18. Section of obliquus externus. |

may be separated, as in McBurney's operation for appendicitis. The wound can be enlarged if necessary by cutting into the rectus sheath and drawing the muscle inwards. By adopting this method the risk of ventral hernia is greatly diminished, and the difficulties of the operation are not materially increased, if good retractors be used.

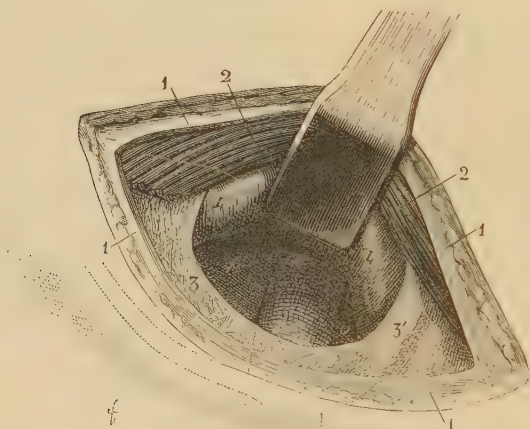
(3) **INCISION OF ABERNETHY.**—In his first operation this surgeon made his incision in the line of the artery for about 3 inches, commencing nearly 4 inches above Poupart's ligament. Later on he modified his incision by making it less vertical and more curved, with

* If the patient be restless, as in delirium tremens, a long splint should be applied.

its convexity downwards and outwards, and extending between the following points—viz., one about 1 inch internal and 1 inch above the anterior superior spine to $1\frac{1}{2}$ inch above and external to the centre of Poupart's ligament.

The respective advantages and disadvantages of the methods of Cooper and Abernethy appear to be the following: Cooper's is rather the easier, interfering, as it does, with the peritonæum less and lower down. It is most suitable to those cases which do not extend far, if at all, above Poupart's ligament. On the other hand, where the extent to which the aneurysm reaches upwards is not exactly known. Abernethy's

FIG. 3.



Ligature of the right external iliac artery. 1, External oblique aponeurosis. 2, Fleishy fibres of internal oblique and transversalis. 3, Transversalis fascia. 4, Peritonæum (drawn up by the retractor). a, Artery. v, Vein. p, Psoas muscle. (Farabeuf.)

operation, hitting off the artery, as it does, higher up, or some modification of that given (p. 16) for ligature of the common iliac, will be found preferable.

Difficulties and Possible Mistakes.

(1) Too short an incision. Here, as in colotomy and other deep operations on the abdominal wall, every layer must be cut to the full extent of the superficial ones. Otherwise the operator will be working at the bottom of a conical, confined wound. (2) A wrongly placed incision—i.e., one which, by going too near the middle line, opens the internal abdominal ring, or which, if too low, may come too near the cord. (3) Disturbing the planes of cellular tissue needlessly or roughly. (4) Wounding the peritonæum, owing to a hasty incision through a thin abdominal wall, by rough use of a director, especially if the peritonæum is adherent in the neighbourhood of the sac, or fused with the transversalis fascia. The peritonæum is often difficult to distinguish; it is bluish in aspect, but of course not smooth, being covered with

cellular tissue which connects it to the extra-peritonæal fat. (5) Stripping up the peritonæum roughly and too far. (6) Detaching the artery from the psoas. (7) Lacerating the psoas. (8) Tying or injuring the vein. (9) Including the genito-crural nerve. (10) An abnormal position of the artery. This may be due to an exaggeration of that naturally tortuous condition of the artery which is especially likely to be met with in patients advanced in life. Another unusual cause of displacement may be met with in extravasated blood when an aneurysm has given way.

Sir W. Fergusson briefly reported (*Brit. Med. Journ.*, 1873, vol. i. p. 286) an instance of this kind, in which the sac gave way after repeated manipulation.

Causes of Failure and Death.

1. Gangrene.—In some cases, where the limb does not become gangrenous, the vitality is very feeble and requires much attention.

Thus, in Mr. Rivington's case (*Clin. Soc. Trans.*, vol. xix. p. 45), loss of sensation was noticed on the fourth day, followed by paralysis of most of the muscles. Though gangrene did not appear, and the patient survived five and a half months, the limb was "on the verge of gangrene," as shown by sores appearing on the heel and great toe.*

2. Secondary hæmorrhage.—This is especially likely if the wound becomes septic and if silk is used. This fatal result may be long deferred.

Thus, in Mr. Rivington's case (*loc. supra cit.*), the patient died of secondary hæmorrhage five and a half months after the operation; the wound had been found septic at the first dressing; a catgut ligature was used.

Early recurrence of pulsation may be ominous of secondary hæmorrhage.

In a case of Sir A. Cooper, the hæmorrhage which proved fatal a fortnight after the operation was found to be due to a large collateral—viz., an abnormal obturator arising immediately above the site of ligature (Roux, *Parallèle de la Chir. anglaise avec la Chir. française*, &c., pp. 278, 279).

3. Cellulitis. Septicæmia. Pyæmia.—Owing to the number of planes of cellular tissue met with here, any needless or rough disturbance of the parts, inadequate drainage, or a septic condition supervening are extremely to be deprecated. The wound should be opened up at once if any collection of fluid is suspected. 4. Peritonitis. 5. Phlebitis and secondary hæmorrhage from injury to the external iliac vein. 6. Suppuration of the sac with its attendant dangers of septic infection and secondary hæmorrhage.†—This accident is far from uncommon in cases of inguinal aneurysm after ligature. No pains should be spared to prevent its occurrence by taking every step to keep the wound strictly aseptic from first to last, and thus to secure early and sound healing. Absolute rest should also be enforced upon

* In one of Dr. Sheen's cases already referred to, four days after the operation a large patch of skin on the outer side of the thigh was noticed to be darkish in colour, and to pit on pressure, though normal as to sensation. The case did quite well.

† Very occasionally secondary hæmorrhage may take place to a slight amount, and leave off spontaneously. Thus, in one of Dr. Sheen's cases, five weeks after the operation "about an ounce of bright-red blood came from the slight remaining wound, and a slight oozing again after a few days, but there was no further hæmorrhage."

the patient. If suppuration take place it will usually be within two months of the date of ligature. The symptoms need not be alluded to here beyond pointing out that pulsation is one of very grave omen. When it is evident that suppuration, if not established, is inevitable, the surgeon should so arrange his time as to choose a suitable occasion, both as to assistance and a good light, for interfering. Allowing the suppurating sac to open spontaneously should not be thought of, not only because of the risk of hæmorrhage, the want of preparation, &c., but because septic infection is now made very probable. The operative steps are much the same as in the old operation for aneurysm, for which the reader is referred to p. 29. It may be here pointed out that in this case there is more chance of the hæmorrhage taking the form of a general oozing from the sac, and not that of a gush or spirt of blood. Moreover, if the collateral circulation has been well established, there is also the probability of the sac being fed by some additional branch, which, perhaps, entering deep down, may be a cause of much embarrassment. 7. Recurrence of pulsation.—This is especially likely to occur when a catgut ligature has been used and given way, owing to its being softened by suppuration. Over-free collateral circulation will cause recurrence of pulsation quickly; and melting down of soft coagulum (this appearing to be all that the blood can do in the way of clotting) will bring about the same cause of failure later on. In these cases the following courses are open in the matter of the external iliac—viz., well-adjusted and carefully-maintained pressure, and the old operation. Ligature of the vessel lower down—i.e., between the first ligature and the aneurysm—and amputation are not available here.* Two other conditions which may supervene and prove troublesome should be mentioned here—viz.: 8. Formation of a ventral hernia.—This should be prevented as far as possible by ensuring primary union, and by the use of deep chronic-gut sutures in the cut muscles. Later on, if this complication threaten, an appropriate belt should be worn. 9. Coming away of the ligature long after the operation, through a persistent sinus or re-opened wound.—This may happen, even in a wound kept sweet from first to last, if a silk ligature has not been properly sterilised, or has been infected from the fingers of the operator.

LIGATURE OF THE COMMON ILIAC (Figs. 4 and 5).

Indications.—Very few:

1.—Aneurysms.—Especially those inguinal aneurysms which affect the external iliac in its upper part, above the origin of the deep epigastric, occupying the iliac fossa and lower part of the abdomen. When such aneurysms are progressing steadily, when they have resisted

* In one case (*Syd. Soc. Bien. Retr.*, 1873-4, p. 220), after ligature of the external iliac for a femoral aneurysm with catgut, and premature absorption of this on the fifth day (the wound suppurated freely, and antiseptic precautions do not appear to have been taken), pulsation returned, and the swelling enlarged. The patient was operated upon again, and a stout carbolised hempen ligature made use of, one end being left long. Though, owing to the close matting of parts, the peritonæum was wounded twice, and intestines and omentum protruded, the patient recovered.

a trial of pressure, or are becoming diffuse, and are not thought amenable to the old operation, ligature of the common iliac is indicated.

The following remarks by one of the chief living authorities on aneurysm, Mr. Holmes (R.C.S. Lectures, *Lancet*, 1873, vol. i. p. 297), will aid the surgeon in coming to a decision in this most important matter:

"Allowing that an iliac aneurysm is amenable to all three methods of treatment—the Hunterian, by ligature of the aorta or common iliac; the old operation, by laying open the sac and securing the artery or arteries opening into and out of it; and the method of compression applied to the aorta or common iliac,—I think no one could deny that the number of cures by the latter method bears a very large proportion to the number of cases treated, while the cures by the Hunterian method are very rare, and the other method is as yet pretty nearly untried.

"But this is far from settling the question; compression, doubtless, often succeeds, but it also often fails. It is not without its risks. It usually requires the prolonged use of chloroform, and this cannot always be borne by the patient.

"The question of applying the old method in preference to the Hunterian in those cases (rare, it may be, but which must sometimes be met with) in which pressure has failed, is one which Mr. Syme's brilliant operations have put in a totally new light. And I must say, for my own part, that, looking at the awful mortality which has attended the ligature of the common iliac for aneurysm, and the uniform fatality of the same operation on the aorta, I think Mr. Syme's suggestion ought to be put to the test of more extended experience, although the facts and reasonings which I have adduced will show that I am not insensible to the risks which attend the performance of the operation, to the probability of secondary hæmorrhage, and to the extensive injury which must be inflicted upon parts in the immediate neighbourhood of important organs."

Mr. Holmes then, in proof of the great fatality of the Hunterian operation on the common iliac, quotes the list collected by Dr. Stephen Smith (*Amer. Journ. Med. Sci.*, July, 1860, vol. xl.), in which, out of fifteen cases in which that vessel was tied for aneurysm, only three can be reckoned as definitely cured.

Mr. Holmes's belief that subsequent experience has not been more favourable is supported by a table of 65 cases, tabulated by Dr. Packard.* Of these 65 cases, no fewer than 51 died, only 14 recovering, giving a general mortality of 78·46 per cent.†

Mr. Holmes goes on to discuss the old operation, and, in answer to the objection that, though the Hunterian operation has been attended with "awful mortality" here, we are not made more secure by operating on an artery, perhaps not much more than three inches lower down, and already involved in disease, writes: "I reply that if we grant the artery where it is involved in the sac to be healthy enough to bear the ligature, many advantages may be found in the old operation over that of Hunter. . . . First, the clot is removed and the sac laid open; consequently, that softening of clot and inflammation of a closed sac lying in proximity to the peritonæum, which is so surely fatal, is obviated. Next, the ligature will probably be placed on the external iliac instead of the common, and thus the chances of gangrene will be greatly diminished, since the internal iliac and its branches are left open. Thirdly, the artery is tied at a point where most likely the peritonæum and viscera have been pushed away from it by the sac, so that there is less

* *Trans. Amer. Surg. Assoc.*, vol. i. p. 234. Sixty-seven cases are given, but the result is not stated in two.

† Grouping these cases into classes, after Dr. Smith's example, in order to obtain more satisfactory deductions, Dr. Packard concludes as follows:—(i.) Those cases in which the operation was done for the arrest of hæmorrhage: 22 cases, of which 19 died and 3 recovered; mortality, 86·36 per cent. (ii.) Those in which it was done for the cure of aneurysm: 35 cases, of which 24 died and 9 recovered, the result not being stated in 2; mortality in 33 cases, 72·72 per cent. (iii.) Those cases in which tumours simulating aneurysm led to its performance: 5 cases, 4 of which died and 1 recovered. (iv.) Those in which the vessel was secured to prevent hæmorrhage during the removal of a morbid growth: 5 cases, all of which died.

risk of hurtful interference with these latter in the operation. And, lastly, the total excision of the tumour precludes any such relapse as occurs sometimes after the Hunterian operation.

"Against these advantages must be set the undoubted risks of secondary hæmorrhage, even in cases where the immediate dangers of the operation have been surmounted. What this risk is we have no means of judging until our experience of this operation becomes greater; but I am under the impression that Mr. Syme much underrated it, in consequence of having operated chiefly upon traumatic aneurysm."

Farther on, Mr. Holmes writes, while "maintaining that the old doctrine on which the superiority of Hunter's operation is based is quite true in general, I should have no objection in the particular instance of iliac aneurysm to follow Mr. Syme's practice; at least, until further experience of it should show that it is wrong: only the less dangerous expedient of rapid compression of the trunk artery under chloroform, or gradual compression, with or without chloroform, should first be tried."

The same authority, when, later on, discussing the value of pressure, brings out the following facts. That, while rapid compression under chloroform is a mode of treatment by which most gratifying success has been obtained in iliac as well as aortic aneurysm, it exposes the patient to serious dangers. Amongst these are enteritis and peritonitis from bruising of small intestine, mesentery, meso-colon, and sympathetic; hæmaturia; failure of pulse and breathing when the pad is screwed down. On account of these very real dangers, which every dexterity may not obviate, Mr. Holmes advocates a trial of gradual compression, as safer though less efficient, and he points out that the relations of the common iliac are less complicated than those of the aorta, and "as we get further to one side, there is more chance for the intestines to slip out of the way."*

2. Wounds.—These may be gunshot or bayonet wounds, or knife-stabs of the vessel itself, or the internal iliac or its branches, usually the latter. The hæmorrhage calling for ligature seems to be usually secondary.† Gunshot wounds of the common iliac have a fresh interest now, owing to the recent advances in surgery in the treatment of gunshot wounds of the abdomen.

Dr. S. Smith‡ gives two cases of ligature of the common iliac for wounds:

One was from a musket-ball which injured the vessel itself, passed through the intestines, and lodged in the sacrum. The operation was performed by opening the peritonæal cavity. Peritonitis soon set in; secondary hæmorrhage recurred repeatedly, and the case ended fatally on the fifteenth day. The other case is of great interest, as the common and internal iliac were here tied for severe hæmorrhage after a stab in the inguinal region. A large quantity of blood was found in the peritonæal cavity, and the patient

* Mr. Holmes draws attention also to this most important point—*i.e.*, that rapid coagulation in an aneurysmal tumour cannot be regarded as in itself a means of cure, but only as the commencement of a process which, if not interrupted, may result in cure, and that thus, while pulsation may diminish soon after a trial of compression, it may not absolutely cease for quite a month.

† It would naturally be thought that hæmorrhage from a wound of the common iliac would be fatal before a ligature could be applied. Dr. Otis gives a case in which this vessel was wounded by a ball entering from the buttock through the sacro-iliac synchondrosis. Death took place from hæmorrhage on the second day.

‡ *Amer. Journ. Med. Sci.*, 1860, vol. xl, p. 1.

died ten hours after the operation. At the necropsy it was found that the deep epigastric was the wounded vessel.

Dr. Otis* records four cases of ligature of the common iliac during the American Civil War :

In one, a gunshot wound, in which the ball entered the groin and came out at the buttock, the external iliac was first tied, the repeated hæmorrhages being believed to be from the profunda ; but as the bleeding persisted and evidently came from the sciatic, the wound was prolonged and the common iliac tied. Both ligatures came away, and the operation wound healed, but the patient died about three months later of exhaustion, associated, apparently, with necrosis in the gluteal region. In the second case the common iliac was tied for a gunshot wound believed to be of the gluteal artery, in which the hæmorrhage was not arrested by tying the internal iliac. The hæmorrhage recurred, and death took place two days later. The third case was one of diffuse aneurysm of the right buttock and iliac fossa resulting from a bayonet-stab in the former region. Death took place four days later from gangrene of the sac. The old operation is considered by Dr. Otis to have been preferable in this case, but as the necropsy showed that the anterior trunk of the internal iliac had been wounded, within the sacro-sciatic notch, by the bayonet, it is difficult to see how the case could have been treated save by ligature of the internal iliac, either outside or within the peritonæum, and then by opening and filling the aneurysmal sac with aseptic gauze or sponges. The fourth case was one of aneurysmal varix of the femoral vessels from a punctured wound two inches below Poupart's ligament. In this case, owing to the impossibility of separating the peritonæum, this was incised, and the common iliac thus secured. Peritonitis proved fatal four days later. Here ligature of the artery lower down, above and below the original seat of injury, would have been better treatment.

3. For the arrest of hæmorrhage apart from aneurysm.—Such cases may be met with after amputation near the hip, followed by secondary hæmorrhage from the branches of the internal iliac in what is usually the posterior flap.

Mr. Liston (*Lond. Med. Gaz.*, April 24, 1830) published a case of this kind in which, after amputation below the trochanter minor for necrosis of the femur, hæmorrhage occurred from the stump on the seventh day. As this could not be arrested, the common iliac was tied, but the patient died twenty-four hours later.

Dr. Packard (*loc. supra cit.*, footnote, p. 11) treated a somewhat similar case in the same way, successfully.

This case is especially interesting, as the hæmorrhage occurred from branches of the internal iliac after a Furneaux Jordan's amputation, a method which has lately come largely into vogue, and which would usually be expected to do away with the above risk.† Hæmorrhage occurred from the stump on the sixth day, and, as pressure failed, the common iliac was tied. The patient ultimately did well.

It will not, it is hoped, seem a hasty criticism on the above if I say that in future cases opening up the flaps and plugging with aseptic gauze, or the application, for some days, of Spencer Wells's forceps, aided by even pressure on the flaps and pressure on the common or external iliac, would be preferable to submitting the patient here to the severe and risky operation of ligature of the common iliac.

4. For pulsating tumours simulating aneurysm.—As these growths from the iliac fossa and the walls of the pelvis have been found to be

* *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 333.

† In Dr. Packard's case the Furneaux Jordan's amputation was performed probably higher up than usual, owing to osteo-myelitis, after a previous amputation for growth, at about the middle of the thigh.

malignant, it is of the utmost importance to form a correct diagnosis in these cases, and thus save a patient who has a certainly fatal disorder from being submitted to an operation which is most dangerous, and almost certain to be useless.* As mistakes have, however, been made in these cases by excellent surgeons,† the chief points of diagnosis, as given by Mr. Holmes,‡ may be briefly mentioned here: (1) The bruit is usually less well marked; (2) the pulsation is less heaving and less expansile; (3) the condition of the bone with which the swelling is connected; thus a plate of bone may be found in the supposed aneurysmal sac; the supposed aneurysm may be found both on the gluteal and the iliac aspects of the pelvis, the bone being expanded by the growth. (4) Cancerous cachexia may be present, and perhaps secondary growths as well. To these may be added the valuable evidence which may be given by the X Rays.

5. For hæmorrhage, not the result of a wound.—Ligature of the common iliac has been employed in some cases of this nature, usually secondary hæmorrhage after ligature of the external iliac, the gluteal and sciatic, or after rupture of the external iliac. Ligature of the main trunk has been so fatal here that it should be abandoned; carefully applied pressure, aided by plugging with aseptic gauze, or the old operation, being certainly preferable.

Mr. Morrant Baker has put on record§ a case of great interest in diagnosis, in which an abscess from sacro-iliac disease ulcerated into branches of the internal iliac artery, and when opened gave rise to hæmorrhage calling for ligature of the common iliac. A gardener, aged 17, had felt pain a month previously while digging. A tense, elastic swelling, distinctly fluctuating, and acutely tender, occupied all the right buttock. It was opened, and a small stream of apparently arterial blood escaped without jets. On further exploration the finger entered a large cavity between the iliac bone and the glutei. The iliac fossa was full and tense, and on examination per rectum a swelling was found in the right ischio-rectal fossa. On enlarging the gluteal wound a steady stream of arterial blood welled up through the great sacro-sciatic foramen. This was firmly plugged, and the common iliac tied. On removing the plug some bleeding still occurred, but was easily arrested. The gluteal wound became offensive, and this region, together with the upper part of the thigh, became gangrenous, the leg and foot remaining unaffected. The patient died forty hours after the operation.

At the necropsy the sacro-iliac joint was open, with surrounding caries. The remains of a large abscess were found, involving the branches of the internal iliac. There was no trace of aneurysm.

6. Preparatory to the removal of caries of pelvis.—Where, after amputation at the hip-joint, pelvic caries persists, leading steadily to lardaceous disease, I think an attempt should be made to remove all of the innominate bone which is diseased. Such profuse oozing follows that the common iliac should first be tied.

* In Guthrie's case, a pulsating tumour in the right buttock, the size of an adult head, diminished by one-half in a month. Two months later it again enlarged, and the patient dying eight months after the operation, an immense encephaloid tumour was found occupying the right iliac region.

† *E.g.*, Guthrie (*Lond. Med. Gaz.*, vol. ii. 1834); Stanley (*Med.-Chir. Trans.*, vol. xxviii.); Moore (*ibid.*, vol. xxxv.).

‡ *Syst. of Surg.*, vol. iii. pp. 44, 145. The reader should also consult Mr. Holmes's article, "On Pulsating Tumours which are not Aneurysmal, and on Aneurysms which are not Pulsating Tumours" (*St. George's Hosp. Rep.*, vol. vii.).

§ *St. Barthol. Hosp. Rep.*, vol. viii. p. 120.

I adopted this course in a boy aged 9, eleven years ago. The common iliac was most easily tied by the free anterior abdominal incision given below, and the pubic part of the bone removed the same day. A little later I removed the ischium and the acetabular portion of the ilium, leaving the upper half. Bronchitis (increased, I fear, by the ether given at the second operation) carried off the child three weeks after ligature of the common iliac. The bleeding was slight and easily arrested, the chief difficulty met with here being the detachment of the soft parts in the neighbourhood of the pubes, tuber ischii, and sacro-iliac joint. The thickening of the pelvic fascia, present in these advanced cases, shuts off the contents of the pelvis.

Surgical Anatomy.—The common iliacs, coming off on the left side of the fourth lumbar vertebra, incline downwards and outwards to divide, opposite to the lumbo-sacral intervertebral disc, into the internal and external iliacs. The right is rather the longer and more oblique of the two. Their length is usually an inch and a half. Their branches are few and small—viz., to the ureter, psoas muscles, glands, &c. The iliacs become increasingly tortuous with age: a point of importance in tying the vessel on an aged corpse.

LINE.—One drawn from a point $1\frac{1}{2}$ inch below and a little to the left of the umbilicus to the centre of Poupart's ligament, the line curving a little outwards, will represent the course of the artery with sufficient accuracy.

GUIDE.—The above line is the only surface guide: more deeply the lumbo-sacral articulation and the psoas muscles are useful guides, especially in a thin subject.*

RELATIONS :—**IN FRONT.**

Peritonæum; small intestine; cæcum and appendix, sometimes.

Ureter.

Sympathetic.

OUTSIDE.

Right common
iliac artery.

INSIDE.

Left common iliac vein.

Psoas.

Vena cava.

Right common
iliac vein.

BEHIND.

Right and left common iliac veins.

IN FRONT.

Peritonæum; small intestine.

Sympathetic.

Ureter.

Superior hæmorrhoidal artery.

OUTSIDE.

Psoas.

Left common
iliac artery.

BEHIND.

Left common iliac vein.

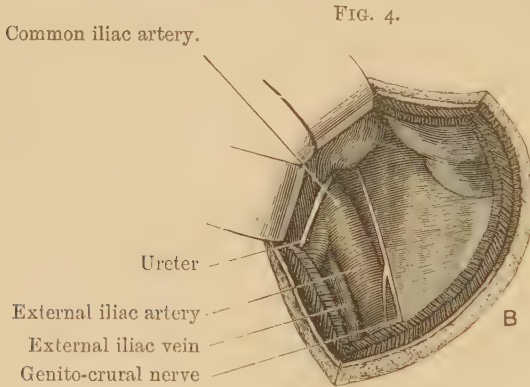
* Attention has been drawn to the need of employing touch, as well as sight, in the ligature of these large trunks (p. 6).

Collateral Circulation.—The chief vessels are :

ABOVE.	BELOW.
Internal mammary and	Deep epigastric.
lower intercostals	with
Lumbar	,,
	Ilio-lumbar and circumflex iliac.
Middle sacral	,,
Superior hæmorrhoidal	,,
	Lateral sacral. Inferior and middle hæmorrhoidal.

In addition, the pubic arteries anastomose behind the symphysis.

Operations (Figs. 4 and 5).—The common iliac may be tied by operations based upon one of three incisions: (1) An anterior abdominal, by which the vessel is approached more directly from the front; an incision based upon those for tying the external iliac, and made use of by Dr. Mott, of New York, who first tied this vessel for aneurysm in



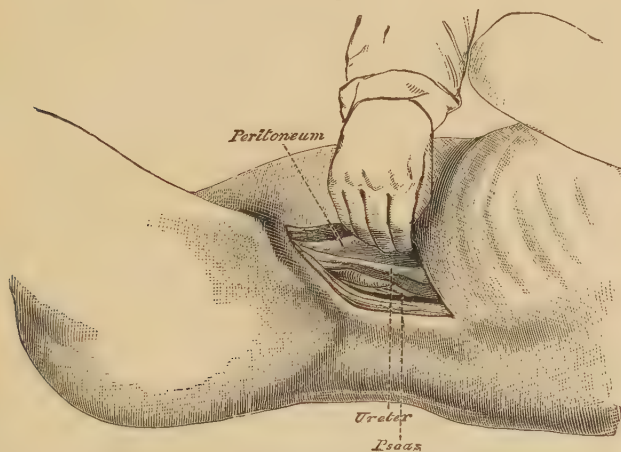
Ligature of the left common iliac artery. The peritonæum has been drawn upwards and inwards, and the bifurcation of the common iliac artery exposed. (Compare Fig. 1, B, and Fig. 2.) (Heath.)

1827. (2) A posterior abdominal, or loin incision, by which the vessel is reached from behind; a method made use of by Sir. P. Crampton, of Dublin, in 1828, and by Mr. Stanley, at St. Bartholomew's, in 1846 (Fig. 5).

(1) *Anterior Abdominal Incision.*—The preparatory treatment is here the same as that for the external iliac. The parts being shaved and cleansed, a curved incision, 5 to 8 inches long, according to the amount of fat, the development of the body, and the size of the aneurysm, is made, commencing just outside the centre of Poupart's ligament and $1\frac{1}{2}$ inch above it, then carried outwards, reaching towards the crest or the ilium, then upwards towards the ribs, and finally curving inwards towards the umbilicus, till sufficiently free to admit of the necessary manipulations for reaching the artery. The three abdominal muscles are cut through, either on a director, or with careful light sweeps of the knife, till the fascia transversalis is reached; any vessels which bleed being at once secured with Spencer Wells's forceps. The fascia transversalis, which may generally be known from the peritonæum by the layer of extra-peritonæal fat which usually intervenes between the

two, is then picked up and divided on a director, at the lower part of the wound where it is best marked.* Adoption of the Trendelenberg position will facilitate the remaining steps. The peritonæum is next raised upwards and inwards, first one finger, and then more, being insinuated towards the middle line until the psoas is reached. On the inner side of this muscle the artery will be found, the external iliac being traced up if needful. In order to aid the surgeon in the difficulties which are now met with, owing to the artery lying at the bottom of a very deep wound, the abdominal walls should be relaxed by bending up the thighs, the wound sponged thoroughly dry, and light thrown in by a reflector or electric lamp. Care will, of course, have been taken to divide every layer from end to end equally, and thus to avoid a conical type of wound. The position of the vessel having been made out, it is to be cleaned with a director, especial care being taken on

FIG. 5.



Ligature of common iliac by a posterior incision. This would also be available for the abdominal aorta. (Bryant.)

the right side, as here both the common iliac veins lie behind the artery. The needle should be passed from within outwards, the ureter being drawn inwards and avoided.

(2) *Posterior Incision, partly in Abdomen, partly in Loin.*—This operation will be best given in the words of Sir P. Crampton,† who first introduced it :

“The first incision‡ commenced at the anterior extremity of the last false rib, proceeding directly downwards to the ilium; it followed the line of the crista ili, keeping a very little within its inner margin, until it terminated at the superior anterior spinous process of that bone; the incision was therefore chiefly curvilinear, the concavity looking towards the navel. The abdominal muscles were then divided to the extent of about an inch, close to the superior anterior spinous process, down to

* Dr. Liddell (*Intern. Encycl. of Surg.*, vol. iii. p. 312) recommends that the separation of this fascia from the peritonæum should be begun at the upper part of the wound, where the adhesion is slightest.

† *Med.-Chir. Trans.*, vol. xvi. p. 161.

‡ The patient would, of course, be rolled over on to the sound side.

the peritonæum; into this wound the forefinger of the left hand was introduced, and passed slowly and cautiously along the line of the crista ilii, separating the peritonæum from the fascia iliaca. A probe-pointed bistoury was now passed along the finger to its extremity, and by raising the heel of the knife, while its point rested firmly at the end of the finger as on a fulcrum, the abdominal muscles were separated from their attachments to the crista ilii by a single stroke. By repeating this manœuvre the wound was prolonged until sufficient room was obtained to pass down the hand between the peritonæum and the fascia iliaca. Detaching the very slight connections which these parts have with each other, I was able to raise up the peritonæal sac, with its contained intestines, on the palm of my hand from the psoas magnus and iliacus internus muscles, and thus obtain a distinct view of all the important parts beneath; and assuredly a more striking view has seldom been presented to the eye of the surgeon. The parts were unobscured by a single drop of blood: there lay the great iliac artery, nearly as large as my finger, beating awfully, at the rate of 120 in a minute, its yellowish white coat contrasting strongly with the dark blue of the iliac vein which lay beside it, and seemed nearly double its size; the ureter in its course to the bladder lay like a white tape across the artery, but in the process of separating the peritonæum it was raised from it with that membrane, to which it remained attached. The fulness of the iliac vein seemed to vary from time to time, now appearing to rise above the level of the artery, and now to subside below it. Nothing could be more easy than to pass a ligature round an artery so situated. The forefinger of the left hand was passed under the artery, which, with a little management, was easily separated from the vein; and on the finger (which served as a guide) a common eyed probe, furnished with a ligature of moistened catgut, was passed under the vessel. A surgeon's knot was made in the ligature, and the noose gradually closed, until Mr. Colles, who held his hand pressed upon the tumour, announced that all pulsation had ceased. A second knot was then made, and one end of the ligature cut off short." Unfortunately, the catgut of that day became quickly dissolved, pulsation returned in the tumour within fifty hours of the operation, and on the tenth day profuse secondary hæmorrhage took place, death following immediately.

Comparison of the Two Methods.—Sir P. Crampton thus speaks of his own and Dr. Mott's operation: "The operation of tying the common iliac artery is not only a feasible but (when performed in the manner described in this paper) an exceedingly easy operation. The difficulties which Dr. Mott encountered, and which prolonged the operation to nearly an hour,* are clearly referable to the circumstance of his incision having been made too low. This, in the first place, brought him in contact with the aneurysmal tumour, from which he was obliged, with great labour and considerable risk, to detach the peritonæum; then he had the whole mass of the tumour between him and the artery which he was to tie; and, lastly, he had the intestines pressing down upon him and producing such a complication of difficulties as I believe few men but himself could have encountered with success."

Mr. Key (*Operative Surgery*, p. 294) preferred the posterior incision for these reasons: (1) It is a part less liable to consequent inflammation. (2) The requisite separation of the peritonæum is less extensive. (3) The artery is brought better into view, the act of passing the needle round it being made visible to observers around. (4) The line of the vessel is sufficiently exposed to enable the operator to select his site of ligature, to carry it either higher or lower, or even, if necessary, to separate the peritonæum from the aorta itself, and to pass a ligature around that

* Sir P. Crampton's operation was completed in twenty-two minutes.

vessel at a sufficient distance from its bifurcation. (5) The formation of a ventral hernia is not likely to occur.

To the above Mr. Skey might have added that the posterior incision gives far better drainage to the wound.

The difficulties of the operation and the causes of failure and of death are much the same as those already given in the account of ligature of the external iliac (pp. 8—10).

(3) *Intraperitonæal Method*.—See p. 22.

LIGATURE OF THE INTERNAL ILIAC.

Indications.—Very few and rare.

i. In some cases of gluteal and sciatic aneurysms.—Mr. Holmes, in the course of those lectures from which I have already quoted, lays down conclusions which will very greatly help the surgeon in deciding what form of treatment is best suited to these aneurysms. They are quoted below under the heading of “Ligature of the Gluteal Artery” (p. 26).

ii. *Hæmorrhage*.—This is most frequently met with in military surgery after gunshot wounds of the vessel itself, but more often of one or more of its branches within the pelvis, the ball entering usually from the front through the inguinal region or behind through the sacrum.

Four such cases are given by Dr. Otis,* all being fatal. Two cases, in which this artery was tied for wounds of the sciatic and gluteal respectively, are given by the above writer (p. 332); both were fatal from hæmorrhage.

Dr. Liddell,† who, as U.S.A. Medical Inspector, saw much of military surgery, gives the following advice in cases of punctured wounds of this artery or its branches: “The wound should be explored by introducing the finger into it for the purpose of locating by touch the precise point whence the blood issues by jets into the wound. If the punctured artery is found to be external to the pelvis, the bleeding point should be laid bare by enlarging and cleansing the wound, and the vessel secured by ligatures placed on each side of the aperture. But if it be shown, by the occurrence of intra-pelvic extravasation of blood, or by other signs, that the internal iliac artery, or some branch thereof, is wounded within the pelvis, it will be impossible to reach and tie the punctured artery in the wound. Under these circumstances it sometimes becomes very difficult to decide what plan of treatment should be adopted. . . . One thing,” Dr. Liddell goes on to say, “ought never to be done, that is, trusting to the use of iron perchloride or persulphate.‡ The first thing to be tried, in most cases, is compression. It should be applied to the common iliac artery, and, at the same time, to the wound itself, if possible, with a view to obtain coagulation of the blood in, and obliteration of, the wounded artery. The very desperateness of these cases makes it all the more necessary to use the compression faithfully, intelligently, and persistently,

* *Med. and Surg. History of the War of the Rebellion*, pt. ii. p. 331.

† *Intern. Encycl. of Surg.*, vol. iii. p. 125.

‡ See the remarks, vol. i. p. 745.

otherwise a traumatic aneurysm will form." Nowadays laparotomy will very likely be resorted to (p. 22).

iii. To bring about atrophy of the enlarged senile prostate.

Dr. Bier, first assistant to Prof. von Esmarch, of Kiel, was the first to tie the internal iliaes for the above purpose (*Wien. Klin. Woch.*, No. 32, Aug. 10, 1893).

He did this in three cases, in one intra-peritonæally and in two extra-peritonæally. The latter two made good recoveries. In the first case the way in which the anæsthetic was taken caused so much trouble that, Trendelenberg's position failing, it was found needful to withdraw a large part of the small intestine, in order to reach the arteries. This patient died of septic peritonitis on the third day.

Dr. W. Meyer (*Ann. of Surg.*, July, 1894) publishes a case treated by Bier's method.

The patient was 55, and very stout. For six months he had been unable to pass any urine, having to rely on a catheter altogether. The prostate was generally enlarged; its upper border could only just be reached *per rectum*. The extra-peritonæal method was adopted. The left artery was taken first. An incision, slightly concave inwards, and five inches long, was made parallel with the upper third of Poupart's ligament and running up towards the tip of the eleventh rib. The common and internal iliaes were reached without much trouble. The artery was tied with catgut, but, the vessel having been punctured when the sheath was divided, two ligatures were applied on either side of the puncture, and the artery was divided between them. The ligature on the proximal end slipped off, and further attempts to place a ligature proving futile, a long pair of artery forceps was placed on each divided end, and left *in situ*, being carefully packed around with gauze. The right internal iliac was then tied with a double catgut ligature, but the vessel was not divided. The two forceps were removed on the fifth day, no hæmorrhage following. On the twelfth day arterial hæmorrhage took place from the track of the forceps on the left side. On opening up the wound it was found that the bleeding came from an opening in the external iliac, due to the pressure of the forceps where it crossed this vessel. Pressure being made on the common iliac, the external was tied above and below the perforation, and then the common iliac was tied also, silk being used on this occasion. Partial gangrene of the foot followed, necessitating an irregular amputation of its anterior part. The influence of tying both internal iliaes in the enlarged prostate in this interesting case was as follows: Twelve hours after the operation the patient began to pass his water (twenty ounces) in a fine stream for the first time for six months. This improvement slowly increased, though it was evident that there was marked atony of the bladder. The patient gained sufficient power to hold his water two, or even three or four, hours, and then to pass ten or twelve ounces in a forcible stream. The residual urine remained considerable, ten ounces or more. The prostate became almost normal in size, and the length of the urethra became reduced from $23\frac{1}{2}$ to $21\frac{1}{2}$ cm., the length of a normal urethra being 21 cm.

Dr. Meyer also operated according to this plan on a man, aged 63, with retention due to hypertrophy of the prostate. A single silk ligature was easily placed around each artery within its sheath, and tied. The wound healed without reaction. The patient voided his urine in a fine forcible stream several times during the night after the operation. Retention did not again set in. On the fifth day after the operation the temperature became subnormal without apparent cause, and the patient died comatose three days later. Only a very limited necropsy was permitted, and there is no account of the state of the kidneys.

We have seen that the two cases in which Dr. Bier operated by the extra-peritonæal method recovered. Neither, before the operation, had been able to pass a drop of urine. Spontaneous power returned in each case, and improved progressively, one of the patients stating, four months later, that he could micturate as well as ever before.

iv. In some cases of vascular pelvic sarcoma, and inoperable uterine tumours (Baudet and Kendirdjy, *Gaz. des Hôpitaux*, April 1, 1899).

v. Also as a prophylactic against hæmorrhage in the course of

certain pelvic operations, such as abdominal panhysterectomy, and in abdomino-perinæal excision of the cancerous rectum (Baudet and Kendirdjy, *loc. supra cit.*).

Surgical Anatomy.—A short trunk, about an inch and a half long, of large size, the internal iliac, given off opposite to the lumbo-sacral intervertebral disc, dips downwards and backwards as far as the upper part of the sacro-sciatic notch, where it gives off its anterior and posterior trunks, a ligamentous cord also coming off from the bifurcation. This cord, the remains of the obliterated hypogastric artery, usually remains pervious as far as the bladder, as one of the vesical arteries.

LINE.—No distinct line or guard can be given for this vessel owing to its at once dipping into the pelvis, but it will be worth while to remember that a line drawn with a slight curve outwards from a point about an inch below and a little to the left of the umbilicus, to the centre of Poupart's ligament, gives sufficiently accurately the line of the common and external iliac arteries; the internal is given off about two inches from the commencement of this line.*

RELATIONS :—

IN FRONT.

Ureter.

Peritonæum.

Rectum (left side).

INSIDE.

Pyriformis.

Sacral nerves.

OUTSIDE.

Right internal iliac vein.

Obturator nerve.

Internal iliac.

BEHIND.

Internal iliac vein.

Sacro-iliac synchondrosis.

Lumbo-sacral cord.

Collateral Circulation.

Sciatic	with	Superior branches of profunda.
Hæmorrhoidal branches	„	Inferior mesenteric.
Pubic branch of obturator	„	Vessel of opposite side.
Branches of pudic	„	Branches of opposite vessel.
Circumflex and perforating of profunda	„	Sciatic and gluteal.
Lateral sacral	„	Middle sacral.
Circumflex iliac	„	Ilio-lumbar and gluteal.

Operation.—The preparatory treatment being the same as in ligature of the external iliac (p. 5), the surgeon makes an incision much as in the case of the common iliac, or else, in the words of Dr. Stevens (who first tied the vessel successfully in 1812), “one about five inches long, parallel with the deep epigastric artery, and nearly half an inch on the outer side of it.” The peritonæum having been raised up, the hips are well flexed, and the lips of the wound retracted as widely as possible. The finger now finds the external iliac, and then, by tracing it up, the

* The origin of the arteries will be found nearly opposite to the centre of a line drawn from the anterior superior spine to the umbilicus.

internal iliac vessel.* The cord of the obturator nerve must not be mistaken for this.†

The artery is now separated, partly with the finger-nail and partly with the point of the director, and the needle passed from within outwards, avoiding the vein and psoas muscle. The ureter usually crosses the artery at its commencement, and will be out of harm's way. It will be well to have in readiness aneurysm-needles of different curves, and an ordinary silver eyed probe.

Ligature of the Internal and other Iliacs by Abdominal Section.
—This method has been advocated by Dr. Dennis,‡ of New York, on account of the following advantages:—(1) Abdominal section in no way increases the dangers of the operation of ligature of the internal iliac. (2) This method prevents a series of accidents which have occurred during the performance of the operation of ligature of this artery by the older methods. Amongst these are, the division of the circumflex and epigastric arteries, wounding the vas deferens, including the ureter in the ligature, puncturing the iliac or circumflex veins, tying the genital branch of the genito-crural, tearing the peritonæum, injury to the sub-peritonæal connective tissue, cellulitis. (3) Abdominal section enables the surgeon to apply the ligature at a point of election, and to obtain information as to the exact extent of the disease in the main arterial trunk. (4) Securing the internal iliac by this method takes much less time than was occupied by the older ones.

Three cases are given by Dr. Dennis, two of which occurred in his own practice:

(1) A woman, aged 60, presented pulsatile tumours in both gluteal regions, the tumours dating back a year and a half, and pain three years back. The external parts being thoroughly purified, a median incision was made from the umbilicus to the pubes; the small intestines, which would have hindered the operation, were drawn out into warm moist sponges and towels, the internal iliacs of both sides ligatured with catgut, the viscera returned, the wound closed, and aseptic dressings applied. The patient died, with suppression of urine and slight parenchymatous nephritis, on the third day. (2) A negro, aged 46, had a right gluteal aneurysm, the trouble dating back seven months. By a curved lateral incision the abdomen was opened; owing to the violent efforts of the patient, and the difficulty of manipulation, a few coils of intestine were drawn out, a strong silk ligature applied to the internal iliac, the parts cleansed, and the wound closed. A cure followed. (3) A female, aged 18, had an aneurysmal varix of the left side, the trouble dating back many years. Under careful antiseptic treatment the abdomen was opened, the incision finally extending from the symphysis to some distance above the umbilicus, the intestines drawn out sufficiently to admit of exposure of the vessel, a double twisted catgut ligature applied to the left internal iliac, the bowels returned, and the wound treated as before. The patient rallied quickly, and the bowels were moved normally on the fifth day; a slight acute albuminuria, due to congestion of the kidney from the ligature of the main trunk of the internal iliac, appeared on the following day, but soon disappeared. The aneurysm, together with the aneurysmal varix, was perfectly cured.

A few cases in which the iliac arteries have been tied intra-peritonæally in this country are on record. One of the most interesting

* The finger should be passed downwards and backwards towards the sacro-iliac synchondrosis.

† In cases of doubt the artery should be compressed gently between the finger and thumb.

‡ *New York Med. News*, Nov. 20, 1886; *Annals of Surgery*, vol. v. No. 1, p. 55. I am indebted to the latter periodical for the above account.

of these is fully recorded by Mr. Makins (*Lancet*, vol. ii. 1892, p. 1328).

The patient, aged 30, had an inguinal aneurysm, about two inches in breadth, extending upwards about two-fifths of the distance between the middle of Poupart's ligament and the umbilicus, and for about two inches below the ligament. An incision four inches long was made in the left linea semilunaris; the deep epigastric, which originated in the swelling, was tied between two ligatures. The small intestines were held over to the right with Messrs. Ballance and Edmunds' broad abdominal retractor; the sigmoid flexure was pushed upwards, and an incision made through the lower part of its mesentery and the peritonæum at the margin of the pelvis in the course of the external iliac. The wound was deep, there being about an inch and a half of subcutaneous fat, and abundance of fat in the sub-peritonæal tissue, both beneath the anterior abdominal wall and around the vessel. This, together with some retching, rendered the freeing of the artery and the passage of the ligature a process of some difficulty. The spermatic vessels were also exposed and swelled up considerably in the wound. The artery was secured about three-quarters of an inch below the bifurcation of the common iliac, and an inch and a half above the sac. Two threads of stout flossy sterilised silk were tied separately, but in close apposition, and with sufficient firmness to rupture the internal and middle coats. The posterior peritonæum was sutured over the artery. The patient left the hospital, with the aneurysm hard, painless, and shrinking, on the forty-seventh day.

The following remarks from Mr. Makins, well known not only as a surgeon but also as an anatomist, I quote *verbatim* :

"The reason for selection of the intra-peritonæal method in this case was the high position of the aneurysm. Before operation the pulsation in the iliac fossa was so forcible and extensive that it seemed probable that it might prove necessary to ligature the common iliac, and it was thought that this would be more readily performed by the intra-peritonæal method. Beyond this the intra-peritonæal method seemed to offer the great advantage of not in the least interfering with the coverings of the sac, which, by the ordinary method, might have been disturbed by the stripping of the peritonæum. The experience gained by the operation showed that the usual method might have been safely adopted, but this could not be definitely determined beforehand. An advantage was gained in ready access to the deep epigastric artery, which, as directly feeding the sac itself, needed ligature, but, of course, might readily have been secured by an extension of the ordinary wound. As to the comparative difficulty of the two operations I think there is little to choose, and on the whole the incision for the extra-peritonæal method is perhaps to be preferred in the matter of cicatrix; in the vertical incision the advantage of suturing the fibrous structures in the linea semilunaris is gained; but, on the other hand, the resulting cicatrix passes directly through from skin to peritonæum. In the oblique incision the decussation of the various muscular layers leads to a certain intricacy and irregularity in the line of the cicatrix which may render it the stronger, since pressure is less readily brought to bear directly upon it. The choice of the iliac vessels obtained is, I think, a real advantage, since the incision needs neither extension nor modification; but in saying this it should be pointed out that this is a much stronger argument on the right than on the left side of the body. Ligature of the right common iliac artery by the intra-peritonæal method is probably the easiest of all the operations on the great arteries, since the vessel lies directly beneath the peritonæum of the posterior abdominal wall, uncovered by any structure of importance. On the left side, on the other hand, the inferior mesenteric vessels as they enter the sigmoid mesocolon, and pass down to the mesorectum, cover practically the whole of the artery, and to reach the common iliac comfortably and safely the peritonæum would need to be divided close to the left of the median line of the sacrum and displaced outwards. This manœuvre has the disadvantage of exposing the vein freely, but this would probably give far less trouble than the numerous mesenteric vessels would when swollen by reason of the loss of their peritonæal support. In the case recorded above the distension of the spermatic vessels, when set free by the division of the peritonæum, was much greater than would have been expected."

This most instructive case possesses the additional and especial interest that the patient developed a similar aneurysm on the right side a few months later (*Lancet*, vol. ii. 1893, p. 196).

On May 3, 1893, Mr. Makins tied the right external iliac intra-peritonæally. An incision, commencing an inch below the level of the umbilicus and four inches long, was made in the right linea semilunaris. The abdomen being opened, the small intestine was packed away with two small sponges, and the posterior wall exposed. The artery was then seen below the termination of the ileum, crossed by the spermatic vessels. The aneurysmal sac was about an inch and a half in diameter. The peritonæum over the artery being divided, the vessel was ligatured with two strands of floss silk, tied with separate reef-knots, and then the peritonæum sutured over the artery. The patient was kept in bed for two weeks, and went out on the thirty-eighth day, having made an excellent recovery. A firm linear scar was present in the left linea semilunaris, and two small, hard swellings marked the site of the cured aneurysms. Mr. Makins stated that he repeated the transperitonæal method here, because the first had proved so successful, and because the aneurysm, though small, was situated entirely above Poupart's ligament. The operation on the right side proved much easier than that on the left, since the crossing of the ileum was on a higher level than was the case with the sigmoid mesocolon. The artery also was far more prominent on the brim of the pelvis. The circulation was re-established much more rapidly and satisfactorily after the second than after the first operation. On the first occasion the limb was very cold, and the patient suffered much neuralgic pain; on the second the local temperature fell little, if at all, and the patient had no pain. On the first occasion the deep epigastric was tied, a step not taken on the second, but Mr. Makins was inclined to think that the rapid re-establishment of the circulation was rather dependent on the enlargement of the branches of the internal iliac on the opposite side resulting from the obstruction of the first external iliac artery.

The two following cases, in which abdominal section was resorted to for ligature of the external iliac, show a striking contrast in the difficulties which may be met with:

In Mr. Mitchell-Banks' case (*Brit. Med. Journ.*, vol. ii. 1892, p. 1163), the patient, aged 62, had an ilio-femoral aneurysm as big as a fist occupying the upper part of the right Scarpa's triangle, pushing its way up beneath Poupart's ligament. On September 20, 1892, the abdominal cavity was opened by an incision about three inches long in the right linea semilunaris. The cæcum and small intestines which came into view were held apart by the hands of an assistant. The position of the external iliac being readily detected, the artery was tied with catgut, and sufficient pressure used to stop the pulsation in the aneurysm, and no more, no attempt being made to divide the internal coat. The incision in the peritonæum immediately over the artery was stitched up with fine catgut, so as to make the artery and ligature once more extra-peritonæal. The patient's recovery was uninterruptedly successful, save for one incident. On the eleventh day the sudden onset of acute præcordial pain and cyanosis, dyspnœa, and collapse was thought to point to detachment of some bit of clot from the neighbourhood of the ligature. These complications gradually disappeared. For some time the aneurysm contained fluid at one part, but gradually contracted, and the patient went out on the forty-second day after the operation.

Mr. Banks states that he made use of the abdominal section here because the aneurysm pushed well up beneath Poupart's ligament, and he could not make out with certainty what was the condition of the artery above it.

The second case, under the care of Mr. W. H. Brown, of Leeds, tells a very different story of the difficulties which may attend ligature of the external iliac by abdominal section:

The patient, a woman, aged 48, was admitted into the Leeds General Infirmary with two femoral aneurysms. The upper one, the size of a large cocoa-nut, occupied the

right groin, extending upwards above Poupart's ligament; the second, a smaller one, occupied the middle third of the same right femoral vessel. The skin over the upper swelling was dark, very thin, and threatening to give way. The position of the upper aneurysm was thought to preclude any of the usual operations, and it was decided to tie the external iliac intra-peritonæally, by a median incision. The abdomen was opened by an incision at first four and later six inches long, owing to the great amount of fat in the abdominal wall. The omentum was also very thick, and greatly embarrassed manipulation. It was only after the pelvis had been well raised and emptied of the small intestines that a view could be obtained of the vessel. Mr. Brown states that he had the greatest difficulty in obtaining, first of all, a view of the vessel; secondly, in passing the ligature. So far as the abdominal conditions were concerned the patient made a good recovery, but, the foot and leg becoming gangrenous, amputation of the thigh became necessary. The patient sank about ten weeks after the ligature of the artery.

Mr. Wherry (*Lancet*, vol. ii. 1893, p. 136) made use of the intra-peritonæal method for ligature of the left internal iliac in a case of large pulsating sarcoma of the upper, outer, and back parts of the innominate bone. The swelling was too large and vascular to admit of its removal safely.

"An incision was made from below the umbilicus to the pubes. There were two difficulties. Firstly, the vein, which was very large and much in the way, was swollen by the slightest pressure of sponges or retractors upon the upper part. The external or common iliac would have been much easier to tie in this case. There was some venous bleeding, which stopped after the artery was tied, but the vein also was tied by a ligature just below the first one to make it safe. The other difficulty was with the light. Large reflecting refractors were of the greatest use, but an electric light would have been better still." The patient made a good recovery. The swelling at once shrank and ceased to pulsate, and the relief to pain and other distressing symptoms was very great, but no further result is given.

Sir Frederick Treves (*Operative Surgery*, vol. i. p. 213) made use of this method in a boy, aged 16, with a vascular tumour of the buttock, in November, 1889. He employed an incision from the umbilicus to the pubes, and kept the intestines packed up and aside with six sponges.

The following is Sir Frederick Treves' opinion of the merits of the operation (*loc. supra cit.*, p. 211), and he is inclined to extend this method to the common iliac also: "The advantages of this method are obvious. The vessel is easily and fully exposed, and the needle can be passed without risk to the vein or ureter. The operation is simple, and involves but little time. Its dangers are, comparatively speaking, very few. The ligature can be applied accurately at the spot determined upon. The condition of the artery and the surrounding parts can be made out, and a diagnosis confirmed or modified. The great objection that some few years ago would have been urged against the procedure—the risk of acute peritonitis—may be at the present day almost disregarded."

Writing as I do for those whose operative experience is not to be compared with that of Sir Frederick Treves, I hesitate to endorse the above opinion in its entirety. I am of opinion that with the above incision the intestines will sometimes give great trouble. Mr. Maynard (*Ind. Med. Gazette*, vol. xxxviii. No. 7, July, 1903), in tying the right common iliac artery for a diffusing aneurysm of the external iliac, had much trouble with the small intestines, the whole of which had to be drawn out of the abdomen and wrapped in warm sterilised towels.

The operation then became perfectly simple. Mr. Maynard did not have the advantages of the Trendelenberg position, and of broad and deep retractors, both of which are invaluable. The patient died on the seventh day, the cause of death remaining uncertain, for no autopsy was allowed. Mr. Currie (*Annals of Surgery*, vol. iv. 1905, p. 620) records a successful case of transperitonæal ligation of the left external iliac for aneurysm of its lower part. A median incision was used, and the artery was easily tied with the aid of the Trendelenberg position and good retractors. A good deal of handling and exposure will be inevitable, and we all know that where the above are entailed septic peritonitis does still, in spite of the advantages of modern surgery, tend to appear. Under favourable circumstances, with modern skill in abdominal surgery, and the advantages of the Trendelenberg position, good intestinal retractors, and reflected light, it is certain that the transperitonæal approach will become more and more popular for the reasons so clearly indicated by Sir Frederick Treves and Mr. Makins (p. 22). This route is particularly suitable for ligation of the internal and common iliacs, and for cases of aneurysm of the external iliac when it is not certain beforehand that a ligature can be safely applied to the external iliac extra-peritonæally. In these a peritonæal incision enables the surgeon to decide whether a ligature can be placed on the external iliac or must be applied to the common iliac—a much more risky procedure as regards gangrene of the foot and leg. In fairness I must add that I have only once tied either of the iliac vessels—the common iliac in the case mentioned at p. 15. The free incision there made use of would have rendered the securing of the internal iliac as easy as it did that of the parent trunk. In gunshot injuries or stabs, the intra-peritonæal method will, of course, be made use of. My readers should refer to Mr. Makins' opinion on the intra-peritonæal method, quoted at p. 22.

LIGATURE OF THE GLUTEAL ARTERY.

Indications.

1. Stab. 2. Aneurysm. 3. Hæmorrhage after opening an abscess. All are rare, especially the last.

1. Stab.—The source of the bleeding from a stab in the buttock may be very difficult to tell exactly. The surgeon may be guided by the position of the exit of the gluteal and sciatic vessels (Fig. 6); he will remember the outline of the gluteus maximus, the lower border of this muscle forming the fold of the buttock, the upper starting from the crest about two inches in front of the posterior superior spine, and running downwards and forwards to the greater trochanter. Hæmorrhage from a stab in the upper part of this muscle will probably come from the gluteal; if from the lower part, from the gluteal or sciatic.

2. Aneurysm.—This affection is so rare that it will be sufficient to quote the following conclusions of Mr. Holmes*:

(1) "Gluteal aneurysms, both traumatic and spontaneous, are very favourably circumstanced for the treatment by either rapid or gradual compression applied to the aorta or common iliac."

* Hunt. Lect., *Lancet*, 1874, vol. ii. p. 76; *Syst. of Surg.*, vol. iii. p. 148.

Mr. Holmes points out that gluteal aneurysm, if not ruptured, is usually of no great size, and does not encroach upon the abdomen, and thus any part of the common iliac or aorta is accessible to pressure.

(2) "If this treatment, with or without anæsthetics, does not succeed by itself, it may be supplemented by coagulating injection or galvano-puncture, while the patient is narcotised, and the circulation commanded." Of the two Mr. Holmes prefers galvano-puncture.*

(3) "When such treatment fails, and particularly in aneurysms with imperfect or ruptured sacs, where it is not indicated, the internal iliac must be tied when the surgeon thinks that he cannot find the artery outside the pelvis. But when the artery is accessible, the old operation, or the operation of Anel, should be practised, according to the size and extent of the tumour."

In deciding whether the aneurysm is inside or outside the pelvis, the surgeon will see if the pulsation can be commanded by pressure on the artery above the aneurysm, whether the latter can be lifted from the bone, and will also make an examination by vagina or rectum.†

The old operation must always be formidable, and while modern tourniquets may admit of efficient pressure, there is always the risk of fatal hæmorrhage from the artery having retracted into the pelvis.

The method of Anel does not seem likely to be often useful. Of three cases, one only has been successful.

(4) "The ligature of the internal iliac is liable to failure in cases of spontaneous aneurysm from a diseased condition of the coats of the artery, and should always be avoided when other means of treatment are available."

This method has proved fatal in about half the cases operated on. The varying length of the artery, the proximity of the ligature in all cases to large branches and to the sac, have all to be remembered.

Here also ligature of the artery by laparotomy will probably be resorted to in the future (p. 22).

Surgical Anatomy of the Gluteal Artery.—A short, thick branch from the posterior division of the internal iliac, this leaves the pelvis above the pyriformis, through the sacro-sciatic notch. Immediately after its exit it divides into a superficial and a deep portion. The superficial is mainly distributed to the gluteus maximus; the deep lies between the gluteus medius and minimus, and divides into two, the upper branch running along the origin of the gluteus minimus, and the lower running obliquely across this muscle towards the trochanter major. The superior gluteal nerve emerges just below the artery, and sends branches with the deeper portion.

LINE AND GUIDE.—"If a line be drawn from the posterior superior spine to the great trochanter, the limb being slightly flexed and rotated inwards, the point of emergence of the gluteal artery from the upper part of the sciatic notch will correspond with the junction of the upper with the middle third of this line" (MacCormac, *Lig. of Arts.*, p. 126, Figs. 10, 11).

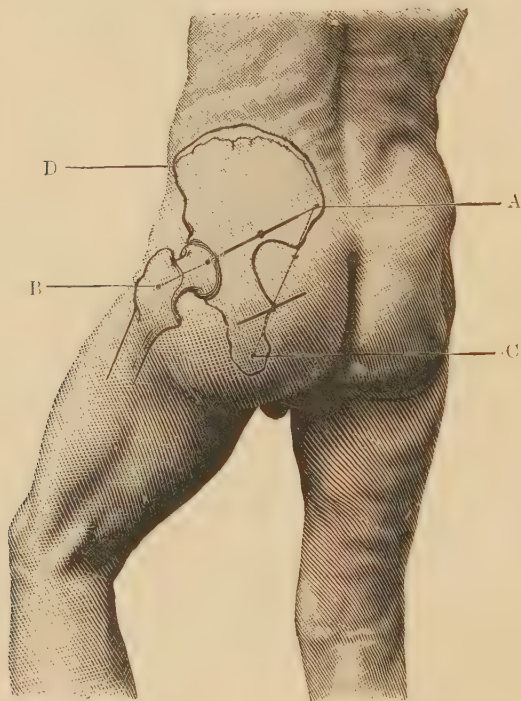
Operation (Fig. 6).—The patient being rolled two-thirds over on to

* See the remarks on the introduction of foreign bodies and galvano-puncture, vol. i. pp. 814–819.

† An anæsthetic being given, and the hand passed here, if needful.

his face, the part well exposed and cleansed, the limb hanging over the edge of the table, an incision, five inches long, is made in a line running from the posterior superior spine to the upper and inner part of the great trochanter. The incision should run almost parallel with

FIG. 6.



Position and direction of the superficial incisions which must be made to secure the gluteal, sciatic, or pudic arteries.

A. Posterior superior iliac spine.

C. Tuberosity of ischium.

B. Great trochanter.

D. Anterior superior iliac spine.

AB. Ilio-trochanteric line, divided into thirds. This line corresponds in direction with the line of the fibres of the gluteus maximus. The incision to reach the gluteal artery is indicated by the darker portion of the line. Its centre is at the junction of the upper and middle thirds of the ilio-trochanteric line, and exactly corresponds with the point of emergence of the gluteal artery from the great sciatic notch.

AC. Ilio-ischiatic line. The incision to reach the sciatic or internal pudic arteries is indicated by the lower dark line. It is also to be made in the direction of the fibres of the gluteus maximus. The centre of the wound corresponds to the junction of the lower and middle thirds of the ilio-ischiatic line. (MacCormac.)

the gluteus maximus. The fibres of this muscle being separated, between adjacent fasciculi, with a director, a muscular branch should be found and traced down to the exit of the artery. The gluteus maximus having been relaxed, and the contiguous margins of the gluteus medius and piriformis separated with retractors, the surgeon, taking as his guide the above line and the aperture of the great sacro-sciatic notch,

clears the artery as high up as possible, avoiding the nerve and the veins, and dividing the adjacent muscles if needful. The ligature should be applied as far within the notch as possible, almost within the pelvis, as the artery divides immediately after its exit.

Old Operation.—The following is the account of Prof. Syme's case. The man had been stabbed in the buttock seven years before. The aneurysm measured more than 13 inches in both diameters; this, together with the great thinness and laxity of the coverings being opposed to coagulation, led to the adoption of the old operation.

"The patient having been rendered unconscious and placed on his right side, I thrust a bistoury into the tumour, over the situation of the gluteal artery, and introduced my finger so as to prevent the blood from flowing, except by occasional gushes which showed what would have been the effect of neglecting this precaution, while I searched for the vessel. Finding it impossible to accomplish the object in this way, I enlarged the wound sufficiently for the introduction of my fingers in succession, until the whole hand was admitted into the cavity, of which the orifice was still so small as to embrace the wrist with a tightness that prevented any continuous hæmorrhage. Being now able to explore the state of things satisfactorily, I found that there was a large mass of dense fibrinous coagulum firmly impacted into the sciatic notch, and, not without using considerable force, succeeded in disengaging the whole of this obstacle to reaching the artery. . . . The gentleman who assisted me being prepared for the next step of the process, I ran my knife rapidly through the whole extent of the tumour, turned out all that was within it, and had the bleeding orifice instantly under subjection by the pressure of a finger. Nothing then remained but to pass a double thread under the vessel and tie it on both sides of the aperture." The case did perfectly well * (*Obs. in Clin. Surg.*, p. 169).

If, in the case of a stab, the hæmorrhage continues after the ligature has been applied with the above precautions, and the gluteal has evidently been punctured within the pelvis, the internal iliac must be tied after the wound in the buttock has been firmly plugged with iodoform gauze wrung out of carbolic acid (1 in 20).

Macewen's Method (vol. i. p. 814).—A case thus treated successfully in the Edinburgh Infirmary by Mr. Miller is recorded (*Brit. Med. Journ.*, 1893, vol. i. p. 1176):

The patient here was aged 75 on June 1, 1891. The surface of the swelling having been well cleansed, six long aseptic steel pins were introduced into the sac in different directions, and made to pass through it until they were felt to impinge against the opposite wall. They were then withdrawn a little so that their points might scratch the inner surface of the cavity. The pulsations of the swelling were sufficiently powerful to move the points of the pins, and to cause them to irritate the internal wall of the aneurysm. They were left in about half an hour, and when withdrawn the punctures were covered with collodion. No anæsthetic was given, nor did the patient complain of much pain. On June 12 the above treatment was repeated, only four pins being used now, since two of those used before were found to be too fine on this occasion, as they bent when force was used to make them perforate the now thickened wall of the aneurysm. On June 25 no pulsation could be detected in the aneurysm, which had shrunk considerably. At this date a pulsating swelling was felt between the xipho-sternum and umbilicus. July 10, the gluteal aneurysm was quite firm to the touch. The abdominal swelling increased rapidly. At first it was thought to be another aneurysm, but it was later diagnosed as malignant, the pulsation of the aorta being transmitted

* Nowadays the application of a Lister's tourniquet to the abdominal aorta would facilitate matters. Another successful case is recorded by Mr. J. Bell, *Prin. of Surg.*, vol. i. p. 1801.

through it. The patient sank on August 30. At the necropsy a large soft sarcoma was found infiltrating the upper part of the abdomen. The gluteal aneurysm was found to be quite firm and solid. It was mostly filled with firm fibrous clot, a small part in the centre being softer.

LIGATURE OF THE SCIATIC ARTERY.

Indications.—Stab. This operation is so rarely required that it may be very briefly described here.

Surgical Anatomy.—The sciatic artery emerges, together with the sciatic nerve and the pudic artery, from the lower part of the great sacro-sciatic notch below the pyriformis.

GUIDE AND LINE.—The limb being rotated inwards, a line is drawn from the posterior superior spine to the ischial tuberosity. The exit of the sciatic and pudic arteries corresponds to the junction of the middle and lower thirds of this line.

Operation (Fig. 6).—The sciatic artery may be found by one of two incisions—(a) by a horizontal one, about five inches long, made about an inch and a half below that for the gluteal artery, and, like that, parallel with the fibres of the gluteus maximus; (b) by one made vertically in the above given line. The deeper guides will be the margins of the notches, or the great sciatic nerve.

LIGATURE OF THE ABDOMINAL AORTA.

Indications.—As this most rare operation has been fatal in every one of the cases in which it has been performed (fifteen, of which only four have been done since the introduction of antiseptic surgery), its justifiability has naturally been called in question. On the one hand, the desperate condition of the patients, the advanced amount of disease probably present in their arteries, hearts, &c., the large and rapid blood-current, the disturbance of very vital parts, and the risk of peritonitis, all combine to render the probability of success extremely small. On the other hand, recent improvements in surgery, the introduction of better ligatures, the fact that in these cases life must speedily end if nothing be done, and, perhaps, the fact that many of the major operations of surgery have been unsuccessful at first, will justify surgeons in again making trial of this forlorn hope, if they feel certain that otherwise the case is quite hopeless. Since R. T. Morris (*loc. infra cit.*) has been able to demonstrate the possibility of making an aortic aneurysm “fill with clots by the application of a temporary ligature to the aorta, and that circulation in the extremities can be re-established on the removal of the ligature,” some hope may be entertained of obtaining a success by a modification of his method.

The cases have mostly been those of iliac and inguinal aneurysm in which other arteries have been tied without success. To justify the epithet above given of “desperate,” the first case, the well-known one of Sir A. Cooper (in 1817),* may be alluded to.

Here the patient had long suffered from an aneurysm affecting the external and common iliac arteries, leading to sloughing of the skin and hæmorrhage. Sir Astley

* *Prin. and Pract. of Surg.* (edited by Dr. Lee), vol. i. p. 228.

having failed in an attempt to perform the old operation, owing to the artery lying so deeply, gave the patient "the only hope of safety" which remained by tying the aorta.

As life was here prolonged for forty hours, and as in Monteiro's case death did not take place till the tenth day, proof is given of the restoration of the collateral circulation.*

Mr. Mitchell Banks records briefly (*Brit. Med. Journ.*, 1892, vol. ii. p. 1164) the following most interesting case:

About fifteen years before, a patient in a state of exhaustion came under his care with a rapidly increasing aneurysmal swelling occupying the left iliac region, and reaching to the middle line in front and to the umbilicus above. "It was impossible to say where it sprang from, but, as the man evidently had only a short time to live, it was necessary to act promptly. I opened the abdomen in the middle line (which was thought rather an adventurous proceeding in those days), with the intention of tying the common iliac, or the aorta itself, if I got a chance. But it was found impossible to do anything. The aneurysm overlapped the left common iliac and the lower portion of the aorta, so that neither of them could be reached. It was a gigantic thing, and had been leaking for some time at the back, tearing up the tissues behind the peritonæum in all directions." The patient sank a few days later. No necropsy is mentioned.

In addition to the above cases in which the aorta has been tied in cases of aneurysm, it has been tied once for hæmorrhage after a gunshot injury of the upper part of the thigh, by Czerny, of Heidelberg. Hæmorrhage continuing, the common femoral was tied, together with the superficial femoral below the profunda. Bleeding taking place again in six days, the common iliac was tied. The hæmorrhage still persisting, it was thought that the external iliac only had been tied, and a ligature was next placed, by mistake, upon the aorta. The patient lived twenty-six hours. The same surgeon during a nephrectomy for a soft malignant growth of the kidney met with such uncontrollable hæmorrhage as to compel him to tie the aorta, the patient dying soon after.

Surgical Anatomy.—The lowest part of the aorta—viz., that between the bifurcation and the origin of the inferior mesenteric—is that which should be chosen.†

The vessel may have in front of it the omentum, duodenum, mesentery, small intestines, and more closely the aortic plexus of the sympathetic, and a layer of fascia of various strength. To the right side lies the vena cava, and behind it are the left lumbar veins. The bifurcation is usually situated a little to the left side of the umbilicus, and about three-quarters of an inch below it.

Operation.—This may be performed (A) through, or (B) behind, the peritonæum. The intra-peritonæal method is especially indicated when the height at which the ligature must be applied, or any evidence of matting of the structures of the abdominal wall (dating to inflammation about the aneurysm, or to the use of pressure), would probably interfere with stripping up the peritonæum.

* In comparing instances of the restoration of the circulation, the one by disease and the other after the surgeon's ligature, the importance of the slow and gradual process in the one case will not be lost sight of. Mr. Barwell (*Intern. Encycl. of Surg.*, vol. iii. p. 481) alludes to the experiments of Pirogoff (Waller and von Gräfe's *Journ.*, Bd. xxvii. S. 122) and a paper by Kast (*Zeit. f. Chir.*, Bd. xii. S. 405) to show that the collateral circulation is established. Sir A. Cooper (*loc. supra cit.*) used to show in his lectures an injected specimen from a dog which survived the operation. Beyond this fact, however, no comparison can be made between the chance of survival of healthy animals and that of patients reduced to such straits as to call for this operation.

† This interval varies in length from half an inch to two inches.

A. *Through the Peritonæum*.—The bowels having been emptied as much as possible, the skin cleansed, the shoulders raised, and the knees slightly flexed, the surgeon makes an incision at least four inches long in the middle line, with its centre opposite to the umbilicus, but curving a little to the left here, so as to avoid the round ligament of the liver and the urachus. The linea alba being found and divided, the fascia transversalis slit up, all hæmorrhage must be arrested before opening the peritonæum.* When this structure has been opened to the whole extent of the wound, deep and broad retractors are inserted, and the small intestine and mesentery drawn partly upwards and partly to the sides, sterile gauze being packed around, if needful, to keep the above structures out of the way. The pulsation of the vessel is now felt for, and the deeper layer of peritonæum carefully scratched through. Care should be taken to disturb as little as possible the aortic plexus † during this step and in passing the needle, which should be carried from right to left.

The ligature used should be one of the flat tape-like ones, of kangaroo tendon or sufficiently stout silk. The passage of the needle may be attended with much difficulty, ‡ not only from the depth of the vessel, and from the presence of intestines if distended and allowed to protrude into the wound, but also from the denseness of the cellular tissue surrounding the artery.

B. *Behind the Peritonæum* (Fig. 5).—This method should be tried in any case where the surgeon is unable to take those precautions for which intra-peritonæal surgery calls. The chief objection is the great depth at which the artery is reached; but it is well worthy of notice that in Monteiro's case, which survived ten days, this method was made use of.

The operation is performed on much the same lines as that already given for ligature of the common iliac (p. 17). The incision should be as free as possible, from the tip of the tenth rib, curving somewhat forwards to the anterior superior spine.§ The muscles and transversalis fascia being cut through, the peritonæum is stripped up and turned inwards, several large retractors placed in the wound, and the ribs dragged up and outwards. The common iliac being found, this vessel is traced up into the aorta (Fig. 5).

* In Mr. James's case (*Med.-Chir. Trans.*, vol. xvi. p. 10) a large quantity of blood was found post mortem in the abdominal cavity. This had come either from a vessel in the parietes, or from one wounded in the mesentery.

† Sir A. Cooper (*loc. supra cit.*) believed that his experiments on dogs proved that inclusion of this plexus, and not the interruption of the circulation, was the cause of the paralysis which followed the experiment. In Mr. James's case, when the ligature was tightened, the patient complained of "deadness in the lower extremities." This was soon followed by agonising pain in the same parts, only relieved by death about three hours after the operation.

‡ Thus, in Mr. James's case the aneurysm-needle broke at its handle, the surgeon having "little anticipated occasion for so much force." In one case the sac gave way during the operation.

§ If necessary, a horizontal one might be added, at right angles to the first, but the rectus and the deep epigastric should on no account be interfered with.

THE SURGICAL TREATMENT OF ABDOMINAL ANEURYSM.

I. Aneurysm of the Abdominal Aorta.—In spite of recent advances in treatment, the prognosis of this disease remains extremely grave. The late Dr. J. H. Bryant (*Clinic. Journ.*, Nov. 25, 1903) found that the average duration of life in these cases is about 13 months from the time that the aneurysm first becomes manifest. He pointed out that the condition was correctly diagnosed during life in only 18 of his 54 cases, and also that the opposite mistake of diagnosing an abdominal aneurysm which is not present is even much more frequent; 67 per cent. of the cases occur in the neighbourhood of the coeliac axis.

A few cases of spontaneous recovery are on record, and Osler (*Lancet*, Oct. 14, 1905) has "seen at least two instances of spontaneous healing in aneurysm of the abdominal aorta." Very little is to be hoped for from medical treatment.

Osler (*Lancet*, Oct. 14, 1905) has never seen a case cured by medical treatment. The Tufnell diet and large doses of iodide of potassium are disappointing and unpleasant; the gelatine treatment is dangerous, and of but little permanent value.

Surgical procedures may prolong life in some cases, and shorten it in others (*vide infra*).

1. Compression above the sac in the rare cases that it is possible to apply it may be successful, as in the case under Dr. Murray, of Newcastle; this patient remained well for six years. This treatment can rarely be employed owing to the high position of the great majority of aortic aneurysms (*vide supra*), and it is not free of danger, the intestines and other viscera being liable to serious injury from compression against the spine.

The latter objections apply equally to distal compression.

2. **Treatment by Acupuncture.**—This method has been fully alluded to at p. 814, vol. i.; and a brilliantly successful case of abdominal aneurysm treated by Prof. Macewen with needles, and the formation of white thrombi, will be found at p. 816, vol. i. This patient was at work for over 2½ years after the treatment.

The only safe method of applying this and the galvano-puncture treatment of Velpeau is after laparotomy, the overlying viscera may otherwise be injured.

3. **Treatment by the Introduction of Wire (Moore).**—This method has been described at p. 813, vol. i. Prof. Loreta, of Bologna, has applied it to one case of abdominal aneurysm which attracted much attention at the time, but proved, as is so common in these cases, only temporarily successful. An account will be found (*Brit. Med. Journ.*, vol. i. 1885, pp. 745, 955), taken from the original paper (*Mem. Roy. Acad. Scien. Institute of Bologna*, Feb. 8, 1885).

The patient was a sailor, aged 30, who had always had good health, save for syphilis five years before. Nearly two years before his admission he had felt something give way in the belly while making violent efforts. A large aneurysm occupied the epigastric and left hypochondriac regions. An incision having been made from the ensiform cartilage

to the umbilicus, numerous superficial adhesions were found, and carefully separated, but it was found impossible thus to deal with deeper ones uniting the sac to the stomach, spleen, and diaphragm. Hence it was impossible to trace the aneurysm to its mouth, nor could it be compressed and emptied. It remained uncertain, therefore, at the time, whether the aorta or one of its branches was the vessel involved. The vessel, which was now fully exposed on its right side, was punctured with a fine trocar, and silvered copper wire passed in from above downwards and to the left. As soon as the wire met resistance the cannula was removed, the end of the wire pushed in, and the puncture brushed over with pure carbolic acid. A little over two yards had been introduced. The after-course was one of rapid and progressive recovery. The man was allowed to get up at the end of six weeks, the swelling having consolidated, the bruit having disappeared, the pulsation being only communicated, and the femoral pulse, which had been almost suppressed, having reappeared. The patient died suddenly, ninety-two days after the operation, from rupture of the aorta immediately below the sac at the angle of juncture between this and the aorta. The sac, filled with organising fibrin, had shrunk to the size of a walnut. The wire was found unaltered and rolled up in a globular mass. Prof. Loreta suggested that the compression produced by the coagula in the sac might have caused an interference with the blood-supply to the arterial wall just below the swelling, and so induced rupture of an artery no doubt already diseased.

D'Arcy Power and Colt (*Lancet*, Sept. 19, 1903) reported a case in which 80 inches of silver wire were introduced into an abdominal aneurysm through an ingenious but rather complicated instrument invented by Mr. Colt. Pulsation diminished but did not vanish. The patient died 50 hours after the operation. A loop of wire had passed into the aortic arch, but most of it was coiled up within the sac amongst recent clots which filled the sac. The whole operation lasted about half an hour, but the actual introduction of the wire only took 2½ minutes. The hole in the sac was easily closed with a few Lembert sutures.

The following advantages are claimed for the instrument: Quickness, kinking of the wire is avoided, and the risk of hæmorrhage is greatly diminished.

Maunsell (*Brit. Med. Journ.*, June 18, 1904) collected 8 cases of abdominal aneurysm treated by Moore's method with three cures of the aneurysm. It is not stated how long these cases were observed. The cases that did best were those in which about 5 or 6 feet of wire were used.

4. **The Moore-Corradi Method.**—Corradi (*Lo Sperimentale*, April, 1879, p. 445) introduced a modification of Moore's method; having passed 17 in. of wire into a thoracic aneurysm, he then sent a galvanic current through the wire. The patient survived for 13 weeks. Hunner (*Bull. Johns Hopkins Hosp.*, Nov., 1900) has collected 23 cases of thoracic and abdominal aneurysms treated by Corradi's method, with four cures, one improvement and prolongation of life, and "ten in which death was probably hastened."

Maunsell (*loc. cit.*) collected 8 abdominal cases, including his own interesting case. One of these patients was cured.

Maunsell having exposed the aneurysm which was in the coeliac axis region, passed six yards of sterilised fine silver wire through a fine cannula. The patient improved for a time, but died from rupture of the aneurysm into the stomach on the 45th day. Nearly all the aneurysm was filled with laminated and some recent ante-mortem clot, amongst which the wire was coiled; the wire did not project through the perforation.

The following table from Professor Osler's article (*Lancet*, Oct. 14, 1905) is interesting. Some of these cases are included in Maunsell's collection:—

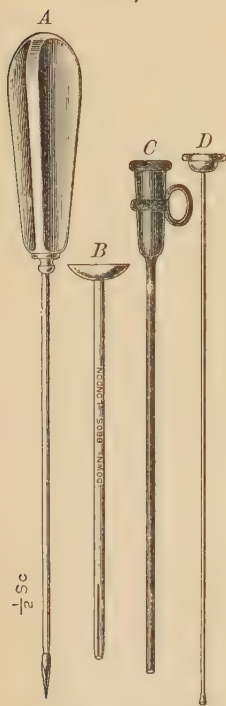
TABLE OF CASES OF ANEURYSM OF THE ABDOMINAL AORTA AT THE JOHNS HOPKINS HOSPITAL, BALTIMORE, U.S.A.

No.	Sex.	Age (years.)	Syphilis.	Alcohol.	Hard work.	Chief symptoms.	Physical signs.	Operation.	Remarks.
1	M.	69	No.	No.	Yes.	Pain, nausea, and vomiting.	Tumour; thrill; no murmur.	Exploratory laparotomy.	Tumour had lasted 3 years; remarkable mobility.
2	F.	36?	?	?	No.	Pain and emaciation.	Enormous non-pulsatile tumour.	Exploratory aspiration.	Huge diffuse aneurysm.
3	M.	33	?	No.	"	Pain; loss of weight.	Enormous pulsating tumour in flank.	Incision: attempt to compress abdominal aorta.	Death on the table; enormous diffuse aneurysm.
4	M.	47	Yes.	Yes.	Yes.	Pain of extraordinary persistency and violence.	Pulsation in back; thrill; systolic murmur.	—	Duration 3½ years.
5	M.	27	"	"	No.	Pain.	Tumour; thrill; systolic and diastolic murmurs.	Wiring and electrolysis.	Death in 48 hours; rupture through the diaphragm.
6	M.	36	"	"	"	"	Tumour; systolic murmur; pulsation behind.	—	—
7	M.	68	"	"	Yes.	No symptoms.	Large tumour; systolic murmur.	—	—
8	M.	36	"	"	No.	Great pain.	Tumour; systolic bruit.	Wiring and electrolysis.	Death on ninth day; rupture into peritonæum.
9	F.	33	?	?	Yes.	Pain.	Large tumour; systolic and diastolic bruits.	—	—
10	M.	53	Yes.	No.	No.	No pain.	Large tumour; systolic and diastolic murmurs.	Wiring and electrolysis.	Discharged in 4 weeks. No change.
11	M.	38	"	Yes.	"	Pains.	Heaving tumour; systolic bruit.	"	Death on fourteenth day; rupture of sac.
12	M.	43	No.	"	"	Pain.	Tumour; thrill; systolic murmur.	"	Pulsation much diminished; discharged in 4 weeks; no subsequent note.
13	M.	30	Yes.	No.	"	Pain; vomiting.	Tumour; thrill; systolic murmur.	"	Great improvement; lived 3½ years.
14	M.	31	"	Yes.	Yes.	No abdominal symptoms.	—	—	Dissecting aneurysm of entire abdominal aorta.
15	M.	54	No.	"	"	Latent.	Death from pneumonia.	—	Aneurysm (sacculated) of abdominal aorta; found post mortem.
16	M.	49	"	"	"	Pain.	Large pulsating tumour; rupture.	Wiring and electrolysis.	Rupture; diffuse aneurysm; death 6 months later.

Griffiths (*Lancet*, Aug. 12, 1905) records an interesting case in which he passed about 6 feet of wire into an aortic aneurysm placed just below the diaphragm. The patient died from shock after 5½ hours. The sac was filled with clot and wire coils. A double loop of the wire had passed into the thoracic aorta for 2½ inches. Much useful information and valuable practical hints are derived from the articles of Maunsell (*loc. cit.*), Griffiths, and Stewart, *Phil. Med. Journ.*, Nov. 12, 1898.

The Operation.—The aneurysm having been exposed through a laparotomy wound, and gauze packing employed to isolate a part of the presenting surface of the sac, a spot devoid of large blood vessels is selected, and a purse-string suture is introduced to encircle a small

FIG. 7.



A, Metal trocar; B, metal cannula; C, vulcanite cannula; D, ramrod. (Griffiths.)

area, through which a fine long trocar and cannula are thrust well into the sac (*vide* Fig. 7, A, B). The trocar is withdrawn, and a vulcanite cannula (C) which fits the metal one accurately, is now introduced for insulating purposes. Sterile fine silver wire (No. 28)* is then introduced through the insulating cannula; if the wire kink it may be cut and driven into the sac by means of the ramrod (D) which has a cupped extremity. From 3-6 feet of wire are introduced according to the size of the aneurysm. Most operators have used too much wire. The wire is passed obliquely, so that its end may not pass straight into the aortic trunk, but may creep along the wall of the sac and coil within it. A current of 15-30 milliampere is passed through the wire for about 15 minutes; 60-80 milliampere currents have been used, but these are apt to damage the sac wall, where the wire comes into contact with it, and moreover clotting is just as good with the weaker currents.

Stewart recommends that the anode should be connected to the wire, and the cathode to a clay plate connected to the patient's back or abdomen. Both poles must not be connected with the sac, and the cathode must not be attached to the wire, for gas is then evolved, and a soft clot formed, which is very different to the firm coagulum formed round the anode. The end of the wire is driven into the sac, and the purse-string suture tightened as the cannulae are withdrawn. The wound in the abdominal wall is then sewn up in the usual way. Some of the dangers of the operation are shock, sepsis, circulatory disturbances arising from sudden increase of the blood pressure, rupture of the sac, or of the aorta near it; this is apt to occur when the aneurysm is shrinking after some days or weeks. Obstruction

* Hunner (*loc. cit.*) prefers $\frac{75 \text{ copper}}{1000 \text{ silver}}$, which is finer and coils better than silver wire.

Silver gold or platinum may be used, but not hard iron or steel, as these snap or perforate the sac. Soft iron is decomposed too readily by the current and may lead to embolism, (Stewart, *loc. cit.*)

of the aorta from pressure of the clotted aneurysm, or projection of the wire into the artery; paralysis or even gangrene of the lower limbs may then occur, or interference with the aortic valves (Reeve, *Johns Hopkins Bull.*, Nov., 1900). Such dangers as are inseparable from the general anæsthesia may be avoided in some cases by the use of eucaine and cocaine. The Moore-Corradi method is certainly worthy of further trial, and is the most hopeful method yet invented for the treatment of the majority of aneurysms of the abdominal aorta.

5. **Ligature of the Abdominal Aorta** (*vide* p. 30).—In only a few cases can a ligature be placed on the proximal side of the aneurysm (*vide supra*, p. 33). Of the two recorded cases one died after one day and the other on the forty-eighth day.

6. **Temporary Ligature of the Aorta.**—Milton (*Lancet*, 1891, vol. i. p. 85) suggested that temporary proximal occlusion of the abdominal aorta might be attained by means of an elastic band, passed round the artery and spine backwards through the loins, where the ends could be tightened at will.

Prof. Keen (*Amer. Journ. of Med. Sci.*, Sept. 1900), who publishes a case of ligature of the abdominal aorta just below the diaphragm, the patient surviving forty-eight days, has devised an instrument by means of which temporary compression of the aorta may be carried out. The instrument, which is fully described and figured, consists of a screw clamp in two parts, which is applied directly to the aorta through an opening in the abdominal wall.

Four experiments on dogs are described, the results of which clearly show the feasibility of the plan.

Prof. Keen considers that the instrument might be used either for a short interval under anæsthesia, or might be left *in situ* for two or three days, during which pressure could be applied at intervals.

R. T. Morris (*Ann. of Surg.*, Feb. 1902) records a most interesting and suggestive case of temporary distal ligation of the abdominal aorta by means of a rubber catheter passed round the artery and kept taut by means of long clamp forceps. The elastic ligature was removed after twenty-seven hours, the aneurysm having filled with clot. Soon afterwards pulsation and sensation returned in the lower extremities. The patient, however, died on the third day from septicæmia, probably the result of gangrene of portions of the intestine which had been compressed by the steel clamp, but the patient also suffered from a previous pyonephrosis.

At the autopsy the aneurysm was found to be filled with clot, but the aortic lumen was patent. At the site of the elastic ligature the internal coat was not divided.

This case proves "that an aneurysm of the aorta can be made to fill with clots by the application of a temporary ligature to the aorta, and that the circulation in the extremities may re-establish on the removal of the ligature.

R. T. Stratton (*Ann. of Surg.*, 1903, vol. xxxviii. p. 256), records five experiments made upon dogs, and advocates the gradual closure of large arteries.

He used waxed cotton tape $\frac{1}{4}$ in. wide, which was passed round the aorta and through a gauze-covered silver tube, "both ends of the tape being fastened to the axle of a small

windlass fixed to the instrument at its outer extremity. The revolving of this tightened or relaxed the tape at the will of the operator. The wheel could be fixed at any point by means of a hinged bar being pressed into small slots in the margin of the wheel." A circular perforated disk was attached to the arterial end of the silver tube, and the perforations for the tape were so arranged that the margins of the tape did not press unduly on and injure the pulsating artery. The pressure was gradually increased and occlusion completed after about 40 hours. No unfavourable symptoms due to the closure were observed. Stratton claims "that these experiments are sufficient to demonstrate the fact that at least in dogs a large artery can be gradually constricted without undue violence to its walls." Crile (*Ann. of Surg.*, April, 1902) had already proved that the carotid arteries could be *gently* occluded for 24–48 hours by clamp pressure without noticeable damage to the arterial wall, and that when the clamp was removed after a number of hours, the circulation was re-established. Crile based his conclusions upon 19 experiments on dogs, and 18 operations on the human being. In no case did thrombosis or embolism occur.

Stratton believes that the gradual occlusion of the abdominal aorta above an aneurysm will be found very serviceable in the treatment of the latter; he maintains that the best results are obtained by the gradual formation of laminated clot within the sac, and not by the sudden clotting of the contents *en masse*. Moreover, the collateral circulation to the abdominal viscera and limbs will thus have time to develop, and the serious symptoms that follow sudden complete occlusion of the aorta will be avoided. Further, it is possible that by this method the circulation through the aorta at the base of the aneurysm to the main arteries below may not be abolished (Morris, *supra cit.*).

Stratton relates a case of aneurysm of the abdominal aorta treated in the manner described above (*Jour. Amer. Med. Assoc.*, March 10, 1906). The constrictor was applied above the sac and gradually tightened. The patient did well for two days, but then sensory and motor paralysis of the lower limbs developed, and death occurred.

The cause of death was the inhibition of the functions of the abdominal viscera, which resulted from the ultimate complete closure of the aorta above the coeliac axis. The sac was filled with stratified clot; there was no injury or necrosis of the aorta.

This method is certainly worthy of further trial.

Aneurysm of the Iliac Arteries.—Proximal ligature is the best treatment for these, and the trans-peritoneal is the safest route to adopt, for this greatly reduces the risk of injuring the sac, and also allows a thorough examination of the vessels above the aneurysm. The ligature can then be applied at any spot selected, and without danger of including important structures like the ureter.

This operation, however, should not be lightly undertaken without the advantages of good assistance and modern conveniences, such as the Trendelenberg position and good intestinal retractors (*vide pp. 22–26*, Mr. Makin's and Mr. Maynard's cases).

Aneurysm of the Hepatic Artery.—Kehr (*Munch. Med. Woch.*, 1903, p. 1861) records a successful case of ligature of the hepatic artery for an aneurysm of that artery which had simulated gall stones at first and later ruptured into the cystic duct causing hæmatemesis.

Haussons, in 1897, collected 22 cases. In only three of these was surgical treatment attempted, and all the patients died.

Ligation or excision may be tried in a similar case, and also in the very rare cases of aneurysm of the splenic and mesenteric arteries.

Aneurysm of the Renal Artery.—Morris ("Diseases of the Kidneys

and Ureters") was only able to collect the accounts of 21 cases of this rare condition, which is usually not diagnosed except during an exploratory operation for supposed ruptured kidney and perinephritic hæmatoma, a new growth, or hydronephrosis. Practically all the cases recorded have not pulsated, being diffuse. The only chance of saving life is by ligature of the renal artery, followed by nephrectomy and removal of the whole sac if possible.

An exploratory lumbar incision having been made, and the aneurysm discovered, the renal pedicle is secured either after stripping the peritonæum forward when the sac is small, or after opening the peritonæum through the linea semilunaris and incising the posterior peritonæum along the outer margin of the colon, which is drawn inwards.

The sac may be so adherent to the intestines or to the diaphragm that it cannot be safely removed in its entirety.

Only four cases have been treated by operation, and three of these recovered, whereas all the cases which were not treated surgically died.

CHAPTER II.

OPERATIONS ON HERNIA.*

OPERATIONS FOR STRANGULATED HERNIA.—RADICAL CURE OF HERNIA.

OPERATIONS FOR STRANGULATED HERNIA.

It is very important to operate early and not to waste valuable time on taxis. Thus Cawardine (*Brit. Med. Journ.*, 1901, vol. ii. p. 573) from an analysis of 183 cases found the mortality to be less than 2 per cent. in those operated upon within 12 hours, more than 10 per cent. when 12—24 hours had elapsed before operation, and that after five days had been wasted 60 per cent. died.

Chief Indications for Operation and Points to bear in Mind.—While this is not the place for going into the above fully, a few practical remarks on those indications usually given may be helpful to some of my readers.

A. Local.—i. A lump in one of the openings, more or less hard, tense, and tender, dull, partly or completely irreducible, and with impulse doubtful or absent.

a. The swelling may be small and deep-seated, as in a bubonocoele near the internal ring, or a femoral hernia in a fat patient.

b. Two herniæ may be present, both irreducible. The surgeon should operate on the one which is the more tense and has the less impulse, and the one which has the more recently descended. If this fail to give relief, either the opposite swelling must be explored or abdominal section performed in the middle line. This step will probably allow of the opposite hernia being reduced from within, and also of any other possible seats of strangulation being explored—viz., the inner aspects of the deeper rings.

c. As to the impulse, it is worth while to observe carefully the point where this ceases. This, probably, is over the site of stricture, and should be about the centre of the incision.

On this most important point, of impulse, Sir W. H. Bennett speaks as follows: In a case of strangulated omental inguinal hernia with commencing gangrene of the omentum, there yet was no interference with the action of the bowels, constipation and vomiting were alike entirely absent, but the symptom which conclusively called for operation was the entire absence of real hernial impulse. The following

* The different forms of hernia, those which present on the thigh as well as the inguinal and umbilical varieties, will be considered here for the sake of convenience, and because they are all abdominal in origin.

remarks on the detection of impulse are worthy of the most careful attention: "The impulse in ordinary non-strangulated hernia, whether the contents of the sac be omentum or bowel, is *expansile* in character, that is to say, the tumour, when the patient coughs or strains, not only rises under the hand, but expands in size. In hernial tumours containing bowel this sudden increase in the bulk is principally due to the additional quantity of gas, &c., which is suddenly driven into the herniated portion of gut by the act of coughing or straining. In omental herniæ the expansion is partly due to the sudden turgescence in the omental vessels, and partly to the increase of tension in the sac due to the cough. Naturally, therefore, the amount of expansion is relatively greater in herniæ containing bowel than in those composed of omentum. . . . In strangulated hernia it is important to understand that absence of impulse does not necessarily mean *immobility* during coughing, for a hernia, even if tightly strangulated, will often move freely under the hand, especially if it be omental. This movement is, however, rather of the nature of a jump or jerk, and is never expansile. There is no question which has a more practical bearing upon the treatment of strangulated hernia than the expansile character of this impulse. It may be safely held as a surgical dictum, that *every case of hernia in which any change has taken place in the condition of the tumour, such as increase of size or tension, whilst expansile impulse is absent, should be regarded as strangulated.*"

d. Sir J. Paget (*Clin. Lect.*, p. 108) thus wrote of the *hardness* of a hernia:—"In large herniæ the hardness may chiefly be felt at and near the neck and mouth of the sac, especially in inguinal herniæ, and you must take care not to be deceived by a sac which is soft and flaccid everywhere except at its mouth, for there may be strangulated intestine in the mouth of the sac though the rest contain only soft omentum or fluid not sufficient to distend it; nay, you must not let even a wholly soft condition of the hernia, or an open external ring, weigh down against the well-marked symptoms of strangulation, for the piece of intestine at the mouth of the sac may be too small to give a sensation of hardness, or the whole hernia may be omental."

B. *General—The Symptoms of Intestinal Obstruction.*—i. Constipation becoming absolute, even as to flatus.—It is well known that small scybalous motions may be forced out by the straining of a patient with a strangulated hernia, anxious to get his bowels to act. Further, and in intestinal obstruction generally, the bubbling away of an enema may simulate the passage of flatus. In those rare cases where, other evidence of strangulation being present, the bowels continue to act at intervals, it is probable that the constriction of the bowel is not complete, and leaves a channel along the mesenteric border (Richter's partial enterocoele). In such cases which have been left long, owing to the absence of constipation and perhaps the slightness of the vomiting, the surgeon must examine the bowel very carefully before he returns it. Constriction, though only partial, may have here caused, from its long duration, thinning or ulceration of the intestine at one spot, and fecal extravasation may take place as soon as the bowel is returned. If there is any reason for doubt in these cases the stricture should be thoroughly divided and the bowel left *in situ*.

Constipation may be absent in cases of strangulation of the omentum alone, or of an appendix epiploica or of the ovary.

ii. Vomiting.*—Especially if (a) this is changing from the early rejection of stomach contents or bile to *feculent* fluid; (b) even if it is repeated only at long intervals, and all other signs are absent or little marked; (c) it must be remembered that vomiting may be stopped by drugs, strangulation persisting, or the intestines may be empty. There is often a deceptive lull in this symptom after two or three days, the vomiting recommencing again later.

iii. Shock more or less severe, according to the suddenness of the onset and the severity of the strangulation.

iv. Colicky pains occurring at short intervals, usually terminating in vomiting. These pains are usually referred to the umbilical region, and are due to the powerful but futile peristalsis of the obstructed small intestine. They are very characteristic of intestinal obstruction.

v. The sunken *sallow* features and anxious countenance and the scanty high coloured urine from intestinal obstruction.

vi. Tympanites and other evidence of peritonitis.

These will not, of course, debar the surgeon from operating, but they will lead him to warn the friends that relief will probably come too late.

STRANGULATED FEMORAL HERNIA (Fig. 7A).

The stomach may be washed out in some cases just before the operation to minimise the dangers incident to the vomiting of foul material during the induction of *anæsthesia* and to lessen the vomiting after the operation.

In bad cases a hypodermic injection of strychnine may be given just before or during the operation. Subcutaneous infusion of a pint or more of saline or saccharine solution is also of great benefit, and can be performed while preparations are being made for the operation. In less severe cases a rectal injection of $\frac{1}{2}$ pint of saline solution may be given.

Operation.†—The parts being shaved and thoroughly cleansed, a little iodoform rubbed in around the genitals, the limbs being kept warm with blankets and a hot bottle or two if the patient's vitality is low, and the knee flexed slightly over a pillow, an incision two and a half to three inches long is made vertically on the inner side of the swelling. Some small branches of the superficial external pudic occasionally require torsion or ligature. The cribriform fascia and the fascia propria (femoral sheath and septum crurale) are next divided

* Sir J. Paget (*loc. supra cit.*, p. 112) says: "If I were asked which of the signs of strangulation I would most rely on as commanding the operation, I should certainly say the vomiting." Later on (p. 114) he urges that the practitioner should not wait for any characteristic mode of vomiting, nor be misled by the absence of any particular fluid, nor even by the absence of all vomiting, nor under-estimating the importance of occasional vomiting as a signal for operation.

† While general *anæsthesia* will be preferred in most cases from the more certain loss of sensibility and the relaxation of the parts, a case related by Dr. Mason (*Brit. Med. Journ.*, vol. i. p. 834) shows how valuable cocaine may be as a local *anæsthetic*. B Eucaïne is, however, far safer and more effectual than cocaine, and if the following mixture recommended by Mr. Barker be employed, there need be no fear of any subsequent sloughing of the skin from the effects of eucaïne: B Eucaïn. gr. iii.; sod. chlor. gr. xii; $\frac{1}{1000}$ adrenalin chlor. sol. $\mathfrak{m}$ x.; water to $\mathfrak{z}$ iiiiiss.

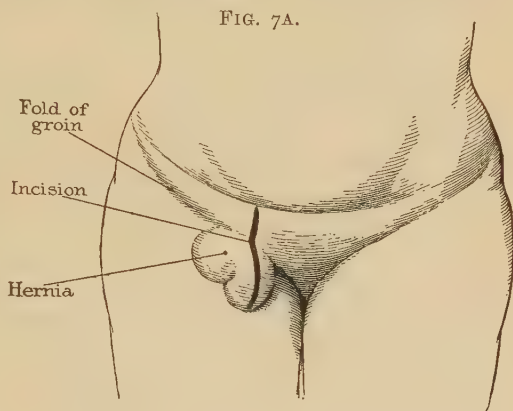
in the same vertical line, with or without a director,* according to their thickness and the experience of the operator, all the incisions made going quite up to and above the top of the swelling, so as to lie over the seat of strangulation, usually Gimbernat's ligament.

The varieties here are best given in Sir James Paget's words (*loc. supra cit.*, p. 132): "In some instances, as you trace up the neck of the sac, you find it tightly banded across by a layer of fibrous tissue called Hey's ligament—a layer traceable as a falciform edge of the fascia lata, where that fascia, bounding the upper part of the saphenous opening, is connected with the crural arch, and is thence continued to Gimbernat's ligament. Sometimes a fair division of this layer of fibres up to the edge of the crural arch is sufficient to render the hernia reducible. . . . But in more cases this is not sufficient, and you may feel the stricture formed by bands of fibres which encircle the neck of the sac, and which must be divided, band by band and layer by layer, till none can be felt. These fibres are part of the deep crural arch. Very rarely, however, even the division of these is not sufficient, for the stricture is formed by thickening of the mouth of the sac itself. This condition, which is a common cause of stricture in inguinal hernia, is very rare in femoral; but it certainly does occur." †

Opening the Sac.—

The sac must always be opened, because of the (1) great importance of examining the bowel; (2) the dangers of opening the sac are very small with due precautions nowadays, and the dangers of reducing the hernia without opening the sac are immeasurably greater; (3) it renders an attempt at radical cure possible, and this should be done in all patients who are not *in extremis*.

In this and in the former case much difficulty is occasionally met with in deciding as to whether the sac is reached or no. The causes of difficulty here are mainly—(1) An altered condition of the soft parts from the pressure of a truss, or from long strangulation; (2) from meeting with fluid outside the sac; (3) from the extreme thinness of the patient, which leads to the sac being reached unexpectedly; (4) from the opposite condition, much fat being met with in several of the deep layers, making it uncertain which is the extra-peritoneal layer, the fat



Site of incision for strangulated femoral hernia.

* The operator can also manage very well with scissors, keen-edged but blunt-pointed, first nicking each layer, and then separating it from the next with the closed points.

† In trying to divide points of stricture outside the sac, attention should be paid to the following :—(1) First reaching the sac itself, if possible, by a careful division of all the overlying structures in the vertical incision carried well upwards; (2) carefully drawing down the sac, so as to expose any fibres constricting its neck; (3) gently insinuating the point of the director under any bands met with,

in these cases being often soft, and readily breaking down under examination; (5) an apparently puzzling number of layers—this condition is usually due to “hair-splitting” over-carefulness on the part of the operator, at other times it is brought about by a much thickened fascia propria separated into imperfect layers by its softened condition or inflammatory matting; (6) by the absence of a sac.*

Aids in Recognising the Sac in Cases of Difficulty.—Several of those ordinarily given (Erichsen, *loc. supra cit.*)—e.g., “its rounded and tense appearance, its filamentous character, and the arborescent appearance of vessels on its surface”—are, I think, quite fallacious. So, too, with regard to the escape of fluid from the sac, for this is often dry in femoral herniæ, and occasionally fluid is met with before the sac is reached. A smooth lining characteristic of its inner surface is more reliable, but the inner surface of the fascia propria is sometimes remarkably smooth. The hernial sac is denser than any of its covering, and of a bluish-white colour. Moreover, the omentum differs from the extra-peritonæal fat in having much larger and characteristic veins. Two points remain which will help to solve the doubt—(a) To draw gently down the doubtful structure, whether sac or bowel, and to examine whether it is continuous above and below with the structures of the abdomen and thigh, like the other coverings of the hernia, or whether it has a distinct neck to be traced into the abdominal cavity; (b) To see if the point of a Key’s director can be insinuated along this last doubtful layer into, and moved within, the peritonæal cavity or no. In a very few cases the surgeon, if still in doubt, incises carefully the suspected layer, and tries if he can pass in a probe and move it from side to side; if this can be done, he is still outside the bowel, not between the peritonæal and muscular coats of intestine. The difficulties here are however so great that several operators have reduced a femoral hernia *en masse* during the operation of herniotomy, and others have only been enabled to prevent this catastrophe by great care. (See “Reduction en Masse,” *Guy’s Hosp. Rep.*, vol. lvi.)

The sac being carefully nicked with the scalpel-blade held horizontally at a spot where it can best be pinched up with dissecting-forceps—a matter of much difficulty at times, owing to its tenseness—is slit up on a director, and its contents examined. If omentum first present itself, this is drawn to one side and unravelled, and intestine sought for. This usually takes the form of a small, very tense knuckle, of varying colour and condition. If it will facilitate the manipulations needful for reduction, the omentum may be first dealt with. (1) If this be voluminous and altered in structure, it should be tied,† bit by bit, with reliable chromic gut or silk, and then cut away, the scissors being applied so close to the ligatures as to leave holding-room, but no excess to mortify or slough. After the return of the intestine, the stump is also replaced within the abdomen. (2) If the omentum be small in amount and

* A sac is said to be absent in some cases of hernia of the cæcum, and where the patient has been operated on before. This, however, was not the case in three herniæ containing the cæcum, and in two which had been operated on before, that have come under my care.

† For security’s sake the ligatures should be made to interlock. If hæmorrhage occur from the omentum after it has been replaced, the surgeon must remember that returned omentum generally escapes far from the wound. It will thus be usually needful to extend the wound upwards along the linea semilunaris.

recently descended, it may be merely returned. (3) In a few rare cases when the omentum is intimately adherent to the sac, and the patient's condition does not admit of delay, the omentum must be left *in situ*. As, however, this course very much interferes with the satisfactory wearing of a truss, and as it is likely to lead to a fresh descent of bowel, it should never be followed if it can be avoided.

Reduction of the Intestine.—As soon as this is exposed, the surgeon examines with the little finger, or a Key's director, the tightness of Gimbernat's ligament. In a few cases reduction may be at once effected by gentle pressure backwards on the bowel with the tip of the little finger. But in the large majority the above site of stricture will need division—a point requiring much carefulness for fear of injuring the intestine or important surrounding structures. If the degree of tightness of the parts admit of it, there is no director so safe and satisfactory as the index or little finger of the left hand passed up to the stricture, the hernia-knife being introduced along the pulp of the finger (Fig. 8).

But there is rarely room for this, and a Key's director† must usually take the place of the finger. The tip of this instrument being insinuated into the peritonæal cavity just under Gimbernat's ligament, the hernia-knife‡ is introduced obliquely or flat-wise upon it, its end slipped under

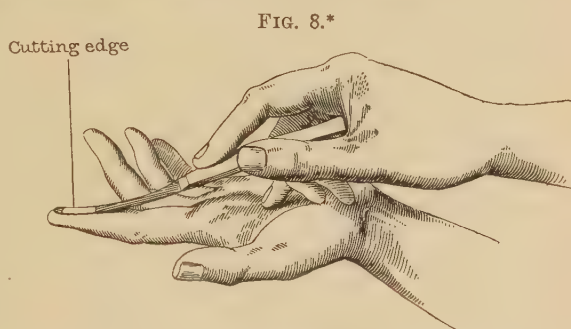


FIG. 8.*

(Fergusson.)

and beyond the ligament, its edge turned towards the constricting fibres, and a few of these gently cut through in an upward and inward direction. In doing this it is well for the surgeon to draw down the edges of the cut sac close to its neck, and to ask an assistant to hold these, thus facilitating the passage of the director and the knife by preventing the sac falling into folds before them. Occasionally, also, a knuckle of intestine persistently coils over the edge of the director. This is best met by patience, by drawing it out of the way by the carbolised finger-tip of an assistant, or by pressing it down with the handle of a pair of dissecting-forceps.

The direction and the extent to which the stricture must be cut are matters of much importance. The upward and inward line is the only path of safety. Directly outwards lies the femoral vein; by cutting

* The cutting blade of the knife shown here is needlessly long and unguarded.

† This director is broad, so as to prevent any intestine curling over and reaching the knife; blunt-pointed, so as not to damage the contents of the peritonæal cavity; finally, its groove does not run quite up to the end, so that the knife-point shall be stopped before it comes in contact with the important parts.

‡ A curved one will be found most useful. The cutting blade is usually too broad and the tip too massive. On the other hand, a worn-down blade has been known to break while dividing a tense Gimbernat's ligament. The intestine may thus be wounded, or the fragment of the knife escape into the peritonæal cavity.

upwards, the spermatic cord, and, if upwards and outwards, the epigastric artery, would be endangered; behind are the peritonæum and pubes. The incision upwards and inwards must be of the nature of a nick; otherwise, owing to the imperfect healing of the fibrous structure, the ring will be left large and gaping, thus facilitating the re-descent of the hernia, producing much difficulty in fitting trusses, and causing certain discomfort and probable peril to the patient, especially if she belong to the poorer, hospital class.

Gimbernat's ligament having been carefully and sufficiently nicked, the bowel is replaced either by gentle squeezing between the finger and thumb, so as to empty it of its contents, or with the pressure of the little finger; the sac being now kept stretched with forceps so that no folds interfere with the return of the bowel. If pressure on one part of the intestine fail, it must be tried at another point. After the reduction of the intestine the tip of the little finger should be introduced through the crural canal into the peritonæal cavity to ascertain that the gut is absolutely safe; a little sterilised iodoform is then dusted on to the stumps of omentum, and these too returned, if this has not been done.

If the patient's condition and age admit of it, and if the adhesions are not too firm, the sac should next be taken away by carefully separating it with the finger or a director from its attachments. It should then be pulled well forwards, an aseptic finger introduced up to its neck, this part next ligatured with stout silk as high up as possible, the finger then withdrawn, and the sac cut away half an inch below the ligature. Unless the condition of the patient is grave, or the tissues have been infected from foul contents of the sac, the femoral ring should be closed in one of the ways described at p. 92. The superficial wound should be sewn up, except at one spot where a cigarette drain can be inserted. The dressings must be applied with sufficient care to keep the wound secure from obviously close sources of contamination. It is well to place a separate pad of carbolicised tow or salicylic wool over the anus and genitals, and to draw the water off before the patient leaves the table. The thigh should not be kept too much flexed, otherwise the escape of discharge from the drainage-tube will be interfered with.

The account of an ordinary operation having been given, it remains to consider certain **complications**. These are chiefly:

1. Adhesions of Bowel to the Sac or Omentum.—The treatment of this uncommon complication must vary with (α) the character and position of the adhesions, (β) the condition of the intestines, and (γ) the state of the patient. Owing to the difficulty of fitting on a truss if any of the hernia is left unreduced, every attempt should be made to free the contents by separating the adhesions with the point of a steel director, or a blunt-pointed bistoury. When near the neck they must always be divided, sufficiently nicked, or stretched. No intestine and omentum still adherent to each other should ever be returned. A few cases remain in which adhesions should be left alone. When gangrene is threatening, but the operator is too short-handed to face resection of the affected intestine, the presence of adhesions, especially about the neck of the sac, is the chief safeguard against extravasation into the peritonæal cavity. In some cases of large hernia,

if the patient be much collapsed, so long as any recently descended loop is returned, any long-adherent intestine may be left. And in other cases of collapse from delay of the operation, where there is much difficulty in returning a loop of intestine, especially if this be not in good condition, it may be left, after the stricture has been sufficiently divided.

It occasionally happens in these cases of deeply congested bowel, especially in inguinal hernia, that after an otherwise successful herniotomy the patient passes profuse and bloody stools. This condition may prove fatal. In one or two cases of this kind which have come under my notice the operator was, most unfairly, blamed for having incised the bowel.

Mr. Kough (*Lancet*, Oct. 11, 1884) records a case in which a patient died in collapse two hours after the reduction of a very large scrotal hernia. The pelvic cavity was full of blood-stained serum; ten feet of intestine were found dark purple in colour, but uninjured. On laying the gut open about a pint and a half of blood escaped.

2. *Tightly Constricted or Gangrenous Intestine.*—In spite of all that has been taught about the importance of early operations, cases do still occur in which returning the bowel is doubtful or out of the question. Nothing is more difficult than to decide upon the treatment of the intestine in doubtful cases. A prompt decision must be made after a careful examination of the intestine, mesentery and contents of the sac, and the general condition of the patient will influence the decision.

(a) *The Intestine.* In some cases of doubt, as long as the stricture is sufficiently divided and the intestine placed only just within the crural ring (the wound being left open and the sac not ligatured), the interior of the abdomen is the best place for the intestine. And this is true of congested intestine, however deeply loaded with blood only, as long as there is some shade of red present. But on these points nothing will surpass the advice of Sir J. Paget (*loc. supra cit.*, p. 138): "You are to judge chiefly from the colour and the tenacity. Use your eyes and your fingers; sometimes your nose; very seldom your ears, for what you may be told about time of strangulation, sensations, and the rest is as likely to mislead you as to guide aright. As to colour . . . I am disposed to say that you may return intestine of any colour short of black, if its texture be good; if it feel tense, elastic, well filled out, and resilient, not collapsed or sticky; and the more the surface of the intestine shines and glistens, the more sure you may be of this rule. When a piece of intestine is thoroughly black, I believe you had better not return it, unless you can be sure that the blackness is wholly from extravasated blood. It may not yet be dead, but it is not likely to recover; and, even if it should not die after being returned, there will be the great risk of its remaining unfit to propel its contents, and helping to bring on death by what appears very frequent—distension and paralysis of the canal above it. But, indeed, utter blackness of strangulated intestine commonly tells of gangrene already; and of this you may be sure if the black textures are lustreless, soft, flaccid or viscid, sticking to the fingers, or looking villous. Intestine in this state should never be returned. Colours about which there can be as little doubt, for signs of gangrene, are white, grey, and green, all dull, lustreless, in blotches or complete over the whole protruded intestine. . . . Then as to the texture of the intestine; it should be, for safety

of return, thin-walled, firm, tense, and elastic, preserving its cylindrical form, smooth, slippery, and glossy. The further the intestine deviates from these characters, the more it loses its gloss and looks villous, the more it feels sticky and is collapsed and out of the cylinder form, the softer and more yielding, the more pulpy, or like wet leather or soaked paper, the less it is fit for return." It is very important to notice whether the blood returns quickly or sluggishly to a portion of the loop of bowel which has been rendered anæmic by the pressure of the finger. It should always be remembered that although the bowel may not be actually gangrenous, it may slough or perforate soon after its reduction, and that in many more cases, without any perforation, the intestinal wall may be so severely damaged as to allow the escape of the virulent germs within it into the peritonæal cavity inducing rapidly fatal peritonitis. A number of patients also die from paralytic distension, and a few from enteritis, or profuse hæmorrhage from the bowel. The dangerous condition of the distended bowel above the obstruction is too apt to be forgotten; it is often in a condition of infiltrating septic inflammation, and its contents are highly poisonous, and owing to paralytic distension drainage is rarely successful in removing this toxic accumulation.

A consideration of the following table inclines us to agree with Mr. Barker's statement that more than one half of the deaths after herniotomy are due to the reduction of too severely damaged bowel.

TABLE.—CAUSES OF DEATH IN CASES DYING AFTER OPERATION
FOR STRANGULATION.

(From a paper by Mr. Barker, *Lancet*, May 30, 1903.)

Sepsis ...	...	...	...	...	...	...	...	2
Sloughing ...	...	...	...	...	...	...	...	12
Peritonitis ...	...	...	...	...	...	...	...	43
Collapse ...	...	...	...	...	...	...	...	17
Asthenia ...	...	...	...	...	...	...	...	14
Lung Troubles ...	...	...	...	...	...	...	...	16
Heart failure ...	...	...	...	...	...	...	...	2
Hæmorrhage ...	...	...	...	...	...	...	...	1
Obstruction ...	...	...	...	...	...	...	...	3
Anæsthetic ...	...	...	...	...	...	...	...	2
Lung embolism ...	...	...	...	...	...	...	...	2
								114
Unascertained ...	...	...	...	...	...	...	...	13
Total ...	...	...	...	...	...	...	...	127

(b) If the mesentery is greatly thickened and firm from inflammatory œdema or interstitial hæmorrhage, if its veins are thrombosed, and its arteries cannot be felt to pulsate, then it is clear that the loop of bowel ought not to be returned into the abdomen.

(c) The nature of the fluid in the sac is also of importance, for if it be foul and sanious, it indicates that the condition of the loop of bowel is so bad as to allow infection through the damaged walls; and the risk of peritonitis incurred by returning such intestine is great. Moreover, some of the septic fluid may trickle into and infect the peritonæum.

In other long-standing cases of femoral hernia the chief stress of the

constriction is shown, not on a dying loop of intestine, but in ulceration, partial or nearly ring-like, at the neck of the sac, under the sharp edge of Gimbernat's ligament. Where this condition, owing to the duration of the case, is suspected, the intestine should be very gently drawn down, and carefully examined; if only a grey or white line be found, this may be inverted by means of a Lembert suture and fortified by a mesenteric flap, and the bowel which is otherwise recoverable may be returned. If the mischief is more severe and approaching perforation, resection is the safest plan.

When it has been decided that the bowel cannot be reduced without undue risk, the surgeon has to decide between (a) the formation of an artificial anus and (b) resection. *Wherever possible, i.e., in cases where the condition of the patient, and the experience, and help ready to the surgeon's hand, admit of his taking this step, the gangrenous intestine should always be resected.*

(a) *In a few cases where the above conditions are absent, the surgeon must rest content with opening the intestine, leaving it in situ, and draining the distended bowel above. The quickest way will be to draw the whole loop that is damaged outside the peritonæal sac, and keep it in place by a sterilised bougie or glass rod of appropriate size, as in inguinal colotomy (q.v.).*

It has been much disputed whether, in these cases, when the intestine is unfit to be returned, it is safe or needful to divide the stricture in addition to laying open the intestine. On the one hand, M. Dupuytren, Sir A. Cooper, Mr. Key, and Sir J. E. Erichsen have advocated this step being taken; on the other, Mr. Travers and Sir W. Lawrence were against it. The following words of a very brilliant writer* will probably convince most that this step is not only injurious but unneeded: "The only result of this is that the protecting barrier, which divides the still aseptic peritonæal cavity from the putrid sac, is broken down, and putridity spreads upwards into the abdomen and kills the patient by rapid septicæmic poisoning. Why break down this valuable wall? If it is argued that, unless the stricture is divided, the contents of the bowel cannot escape, then the reply is that experience proves this to be utterly untrue. In a very short time both flatus and fæces find their way out. As everyone knows, the nipping of the gut is not produced by a sudden narrowing of the hernial aperture, but by a swelling of the loop of gut. . . . When the gut is slit up, its contents are set free, and its inflammatory juices escape, with the result that its swelling goes down, and room enough is soon permitted for wind and fæces to pass, more particularly as the fæces are invariably quite liquid." A rubber tube may be passed along the lumen of the gangrenous loop to the interior of the distended bowel above the constriction and fixed in position by means of a purse-string suture passing through the edges of the intestinal wound and one side of the tube, which should be long enough to drain to a rubber bag at the side of the patient. It is unfortunately true that, although the tube may be passed well into the distended bowel within the abdomen, very little of the pints of putrescent fluid drains away in the worst cases owing

* Sir W. Banks, *Clinical Notes on Two Years' Surgical Work in the Liverpool Royal Infirmary*, p. 96.

to paralysis of the intestine. Few cases which are so desperate as to be suitable for the formation of an artificial anus ultimately recover. In a series of 406 cases of strangulated hernia at University College Hospital (Barker, *loc. supra cit.*), only two out of twenty recovered after this procedure. The reasons for this high mortality are chiefly the desperate general condition of the patient at the time of the operation, which is followed by shock, septic peritonitis from the condition of the distended bowel within the abdomen, suppuration and sloughing in the wound, and, lastly, the mortality of a secondary resection is high in these cases. Shock can be minimised by doing the primary operation under eucaine anæsthesia as recommended above.

(b) **Resection.**—The present high mortality of strangulated hernia will be very considerably lowered by the adoption of primary resection in suitable cases under favourable circumstances. The extension of its use to those doubtful cases in which damaged bowel is too often returned will diminish the mortality of this class, for the general condition of the patient is usually good enough to enable him to bear the shock of a rapid resection performed by a skilful surgeon.

It is important to remember that resections are rarely wide enough; it is of little use to resect the strangulated loop without also removing the distended paralysed bowel above the obstruction. Mr. Barker (April 27, 1901, and *loc. supra cit.*) has laid great stress on the removal of enough of this inflamed and damaged bowel; up to six feet of small intestine may be removed, if necessary, without materially increasing the shock of the resection and without interfering seriously with subsequent nutrition. Between 1899 and May, 1903, Mr. Barker performed seven extensive enterectomies for strangulated hernia with only two deaths, one of these dying from the pressure of an old fibrous band on the bowel after its return into the abdomen, and another from peritonitis, which was probably due to infection from a suppurating hernial sac, which was not drained externally. Hofmeister (*Beit. Z. Klin. Bd.* xxviii. H. 3) also publishes twenty-five primary resections with a mortality of 40 per cent.

It is perhaps needless to say that these extensive resections can only be undertaken by surgeons skilled in intestinal surgery and on patients whose general condition is fairly good. For those patients presenting themselves when *in extremis* the formation of an artificial anus under local anæsthesia still remains the most suitable treatment.

Mr. Barker states that the marked diminution in the mortality of herniotomies at University College Hospital during the four years 1899—1903, was due almost entirely to the successful extensive resections performed in suitable cases. During these years the mortality was reduced from about 25—30 per cent. to 18 per cent.

The operation of resection will be described later (Chapter V.).

3. Wound of Intestine.—This may be due to (a) carelessly incising thin, soft parts; (b) great difficulty in making out the sac and the intestine in a fat patient, with the parts matted, especially if the light is bad; (c) to the intestine being allowed to curl over the edge of the director while the stricture is being divided, or to this being cut with careless freedom, or, lastly, to a loop lying out of sight just above the constriction, and to the hernia-knife coming in contact with this. Any bubbling of flatus or escape of feces must lead to a careful search for

the wound. The operation wound being freely enlarged, the wound in the intestine found, temporarily closed with a Spencer Wells's forceps, and drawn quite out of the abdomen, the intestines around are carefully cleansed and packed out of the way, and protected with tampons of iodoform gauze or flat sponges. When the wound in the intestine is small, it may usually be inverted and closed by means of a purse-string suture of fine silk which picks up only the serous and some of the muscular coat. If the opening be larger, it should be closed by Lembert's suture (*see* Suture of the Intestine). Whichever method is used, the injured part should be replaced just within the peritonæal cavity, and in a severe case the sac should not be taken away or the wound closed.

4. Wound of Obturator Artery.—The position of this vessel when it rises by a common trunk with the deep epigastric instead of from the internal iliac, which occurs in two out of every seven (Gray), may bear a very important relation to the crural ring. In most cases when thus arising abnormally, the artery descends to the obturator foramen close to the external iliac vein, and therefore on the outer side of the crural ring and out of harm's way. In a small minority of cases the artery in its passage downwards curves along the margin of Gimbernat's ligament, and may now be easily wounded.

The treatment is mainly preventive—*i.e.*, by making the smallest possible nick that will be sufficient into any point of stricture, such as Gimbernat's ligament, a point the importance of which has already been alluded to (p. 46), and by using a hernia-knife that is not over-sharp. If the artery has probably been wounded, the following points are of interest:—(1) The hæmorrhage may not at once follow the wound. It may not make its appearance till the bowel is all reduced, or even until a quarter of an hour after the wound has been stitched up. In one case, that of Dupuytren, no hæmorrhage occurred, and the division of the artery was discovered for the first time at the necropsy three weeks after the operation. (2) It may occur when the sac has not been opened. (3) As is shown by Dupuytren's case, it is not necessarily a fatal accident. (4) Very various means have served to arrest the hæmorrhage. (a) Pressure, as in the cases of Sir W. Lawrence, Mr. Hey, and Mr. Barker.* This means was successful in two out of the three cases in which it has been employed. It should only be resorted to when the patient's condition does not admit of the wound being enlarged, and the bleeding points found and dealt with by ligature or forci-pressure. When pressure has to be trusted to, it should be efficiently employed by means of tampons of iodoform gauze wrung out of carbolic acid lotion (1 in 20) and secured on silk. (β) Ligature of the vessel, usually the proximal end. Of five cases given by Mr. Barker, this was successful in four; it is only stated in one that the distal end was also secured. The ligature had been applied in some cases by continuing the wound upwards; in others by making an incision parallel with Poupart's ligament, as if for tying the external iliac. This step should always be taken when the patient's condition is satisfactory.†

* *Clin. Soc. Trans.*, vol. xi. p. 180. This paper will well repay perusal. Most of the above information is taken from it.

† Mr. Hulke (*Lancet*, 1885, vol. i. p. 746), by freely opening up the wound and using

In two of Sir W. Lawrence's cases the fainting of the patient appears to have decided the cessation of hæmorrhage. Both of these recovered. (7) In the event of ligature being really impossible, it might be worth while, before taking other steps, to try the application of a pair of Spencer Wells's forceps. These should be left *in situ* for three or four days, and would favour drainage.

Causes of Hernia not doing well after the Operation (*vide* Table on p. 48).—Most of the bad results are due to one or both of the following causes :—

(a) The reduction into the abdomen of bowel in a severely damaged state.

(b) The operation is still frequently too long delayed.

(1) Peritonitis, indicated by general abdominal tenderness, rigidity, tympanites and vomiting. (2) Collapse from exhaustion. (3) Lung complications such as bronchitis, septic pneumonia, pulmonary embolism. (4) Sepsis, suppuration in the wound, erysipelas, sloughing of the bowel or wound, septicæmia. (5) Enteritis and hæmorrhage from the bowel. The eight following are the causes of intestinal obstruction after operations for hernia: (6) The descent and re-strangulation of the bowel. (7) So much damage to the intestine that it lies paralysed in the peritonæal cavity.* (8) Cicatricial stricture of the intestine. (9) Fixing of the bowel, after its reduction, by adhesions to the abdominal wall.† (10) Formation of a band out of the above adhesions. (11) Fixing of the two ends of a loop of intestine by adhesions. (12) Formation of an omental band in the neighbourhood of one of the hernial orifices, a band so formed causing obstruction later (*Brit. Med. Journ.*, 1879, vol. ii. p. 491). (13) A very rare condition. The sac may be multilocular; when the intestine is reduced it may be returned into one of these cavities instead of within the abdomen. Mr. Bellamy has published such a case (*Lancet*, 1886, vol. ii. p. 433). A good illustration of this is given in Mr. Holmes's *Surgery*, p. 698, Fig. 322; the patient here died eight days after an operation for strangulated hernia. (14) Reduction *en masse* at the operation. This is especially dangerous in femoral hernia.

STRANGULATED INGUINAL HERNIA (Fig. 9).

Operation.—In considering this it will not be needful to go again into detail, as in the case of Strangulated Femoral Hernia; the chief points of difference and those of importance will be considered carefully.

The parts being shaved and cleansed, and the thigh a little flexed, an incision four inches long at first is made in the long axis of the

large retractors, found a comparatively large atheromatous artery spouting freely. From its position this was a large communicating artery between the deep epigastric and obturator, lying just behind Gimbernat's ligament. Both ends were secured with very great difficulty. The patient did well.

* I have recorded (*Brit. Med. Journ.*, 1879, vol. ii. p. 491) an instance of this in which, ten days after an operation for intestinal obstruction by bands, death took place from the intestine never having recovered itself.

† This and the next three are given by Sir Frederick Treves, *Lancet*, 1884, vol. i. p. 1022.

tumour, with its centre (in an ordinary scrotal case*) over the external abdominal ring. The pressure-forceps may be left on the external pudics (both superior and inferior), these vessels being finally closed by the sutures which unite the wound. As the layers are divided, the knife being kept strictly in the same line throughout, some arching fibres of the inter-columnar fascia may be seen above, but the first layer usually recognised is the cremasteric fascia, often much thickened. After this the transversalis fascia, also much thickened and vascular-looking, is slit up, and any extra-peritonæal fat overlying the greyish-blue sac looked for. The surgeon now sees if he can find any constricting fibres outside the sac, and slits them up on a director. The sac must always be opened with the precautions already given (p. 44), the contents are thoroughly examined, omentum got rid of if this step will give more room, and the site of stricture† found with the finger or tip of the director. It is next divided with the hernia-knife manipulated under it in a direction straight upwards, so as to lie parallel with the deep epigastric, whichever side of the hernia this vessel occupies.‡ During this stage the steps given at p. 45 must be taken to avoid any injury to the intestine. The constricting point being divided and dilated, the next step is **reduction of the intestine**. This, in bulky inguinal herniæ, is often a matter of difficulty and time. The **chief causes of difficulty here** are—(1) A large amount of intestine, one or two coils of small and some large intestine being not very uncommon. (2) The distension of these with flatus, &c. (3) Insufficient division of the stricture; or there may be a point of stricture higher up than the one divided, and overlooked. (4) During attempts at reduction one bit of intestine may get jammed across the ring instead of slipping up along it, and against this the rest of the contents are fruitlessly pressed. (5) Folds of the sac may in much the same way block the opening.

Aids in Difficult Cases.—First, that part which lies nearest the ring should be taken—*e.g.*, mesentery before intestine. After each part is got up, pressure should be made on it for a few seconds before another is taken in hand. If the surgeon find, after a while, that he is making no progress with one end of a coil, he should take in hand the other

* In a strangulated bubonocoele the centre of the incision should lie over the internal abdominal ring, and in the deeper part of the incision the deep epigastric must be felt for, and avoided.

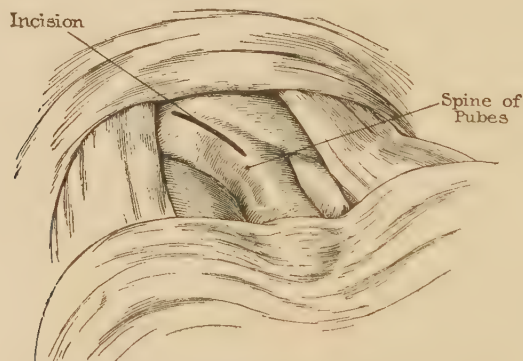
† The site of the stricture in inguinal hernia varies. In both varieties, in old cases of long duration, it is usually situated in the neck of the sac itself, owing to contraction and thickening of this and the extra-peritonæal tissue. In other cases of oblique hernia the stricture is found in the infundibuliform fascia at the internal ring, just below the edge of the internal oblique in the canal, or at the external ring. In a direct hernia the constricting point, if not in the sac, is probably caused by the fibres of the conjoined tendon. In many cases the parts are so approximated and altered that in the short time given for an operation it is not so easy to tell exactly in what tissues lie the strangulation, as to relieve it. Finally, in many cases of young subjects and acute strangulation, muscular spasm—*e.g.*, of the internal oblique—must be borne in mind.

‡ Of course, if the surgeon is certain that he is dealing with an oblique hernia, he may cut outwards, and, in the case of a direct hernia, inwards, so as to avoid the deep epigastric. In all cases the cut should be of the nature of a nick dividing only those fibres which actually constrict, any additional dilatation being usually now effected by the tip of the director or finger,

end, or another coil altogether if more than one be present. Much of the difficulty met with in the reduction of the intestine is due to the surgeon not first unravelling the coil or coils, not duly tracing up the intestine to the ring so as to make out the relations of the two, and, above all, to his not making up his mind which end of the coil it is exactly which he intends to begin reducing. During the manipulations the thigh should be flexed and rotated a little inwards, and the cut edges of the sac drawn tense with forceps, so as to prevent any folding or pushing up of this before the intestine. If the intestines are much distended, attempts should be made to return some of their contents first into the abdominal cavity. If, after gentle squeezing with the finger and thumb, and careful pressure upwards on each successive bit of intestine, it all appears to be returned, the little finger must be passed into the abdominal cavity to make certain that no knuckle remains in the canal or internal ring.

Cases will occasionally be met with, where, owing to the low condition

FIG. 9.



The site of the incision for strangulated inguinal hernia.

of the patient, the large amount of intestine down, its great distension, its altered condition, still red and only congested, but softened, with the peritonæal coat shaggy rather than lustrous, and tending to tear easily, it is clear that reduction will not be effected by manipulation only. If the distension is due to flatus, an oblique puncture may safely be made with a very fine hydrocele trocar, the perforation being inverted and closed by means of a purse-string suture, which is introduced before the fine trocar is used, and which is tightened as the latter is withdrawn. Where fluid fæcal matter is present the above step is dangerous. Where the intestine is much congested and softened, though not yet gangrenous, or where the surgeon has not skilled assistance and all the aids of modern surgery ready to his hand, he had better leave the intestine in the sac after a free division of the stricture.* This method, while

* This will all gradually and slowly return into the peritonæal cavity. On this point the following case by South (Chelius's *Surgery*, vol. ii. p. 40) is of interest :—"I know by experience that if strangulation be relieved, it is of little consequence how much intestine be down. In reference to this point, I recollect the largest scrotal rupture on which I have operated, and in which, before the division of the stricture, there was at least half

under the above conditions the safer, prevents, of course, any attempt at relieving the patient, at one operation, by a radical cure. For a consideration of the points which may aid in deciding on the treatment of bowel in a doubtful condition, or in a gangrenous state, the reader is referred to p. 47.

During any prolonged manipulation of the intestines these should be kept covered as much as possible by iodoform or plain sterile gauze wrung out of hot normal saline solution. It is wise also that the patient should be well under the anæsthetic now, and breathing quietly. If vomiting occur, the surgeon must wait, keeping up pressure on what he has reduced. When the intestine is all reduced, any ligatured stumps of omentum are returned, and, if the condition of the patient admit of it, the sac is detached, one of the methods of radical cure given at pp. 72 to 92 made use of, the precautions as to the cord and other points given at p. 73 being carefully followed.

In this, the wound should be carefully sponged with mercury perchloride solution (1 in 4000), and left exposed as little as possible, especially the parts near the opening into the peritonæum.

In providing drainage after an operation on a large inguinal hernia, where the parts have been much handled either before or during the operation, it is well worth while to bring the lower end of a drainage-tube out at the lower part of the freshly sterilised scrotum, by means of a counter-puncture there, thus ensuring efficient escape of the discharges, and syringing out of the wound if needful.

After thus considering the chief points in the operation, it remains to draw attention to **some special points connected with inguinal hernia.**

I. *Varieties.*—In addition to the oblique and direct varieties, both of which are acquired, there are some others of much practical importance—*e.g.*, (a) Congenital hernia into the funicular process of peritonæum. Here the tubular process of peritonæum is divided into a shut vaginal sac below and an open funicular process above. Into the latter the contents descend, but are not in absolute contact with the testis. (b) Congenital hernia into the tunica vaginalis; the tubular process of the peritonæum is open from the abdomen to the fundus scroti, and the contents lie in contact with the testis. A careful study of the herniæ of infants and children proves that this variety is very much rarer than the first variety. (c) Hour-glass contraction of the sac. Here the tubular process is open as in (b), but an attempt at closure has brought about a constriction which may be at the external abdominal ring or lower down in the scrotum. If the contents pass through this constriction, and get low enough, they will be in actual contact with the testis. (d) Encysted hernia of the tunica vaginalis. Here the funicular process is closed at its upper extremity—*i.e.*, at either ring or in the canal—

a yard of bowel down, filled with air; and, after the stricture had been cut through, at least as much more thrust through, so that I almost despaired of getting any back; yet, after a time, I returned the whole. To my vexation, however, next morning I found that my patient had got out of bed to relieve himself on the chamber-pot, and, as might be expected, the bowel had descended, and in such quantity that the scrotum was at least as big as a quart pot, and the vermicular motion of the intestine was distinctly seen through the stretched skin. Nothing further was done than to keep the tumour raised to the level of the abdominal ring, and by degrees it returned, and the patient never had an untoward symptom."

and open below to the testicle. The hernial protrusion as it comes down either ruptures this septum (when of sudden descent), or gradually inverts it, or comes down behind it. These cases are rare, but may be puzzling when they occur, as the operator has more than one layer of peritonæum to incise before reaching the contents. (e) Interstitial hernia, in which the sac, and often the testicle, lie between the internal and external oblique muscles. The writer recently operated on an infant, in which the condition was bilateral, there were no external rings; the cords were long enough for easy placement of the testis within the scrotum.

That the above varieties have an importance beyond that of anatomical puzzles is shown by the fact that in (a), (c) and (d) strangulation may be very acute and urgent. Again, though the defect is a congenital one, the hernia does not, in many cases, make its appearance till the patient has, in early adult life, been subjected to some sudden strain. Finally, in these cases any prolongation of the taxis will be not only futile, but actually dangerous, owing to the tightness of the strangulation and the facility with which, from the delicacy of its adhesions, the sac may be separated or burst.

II. *Reduction en Masse, and Allied Conditions.*—These have been chiefly met with in inguinal herniæ owing to the loose connections of the sac and, sometimes, to the force used in attempts at reducing large specimens. Strangulation may persist after (a) displacement, or (b) rupture of the sac. In the former, the sac, still strangling its contents at its neck, is displaced bodily between the peritonæum, usually, and extra-peritonæal fascia. In the latter the sac is rent, usually close to its neck and at its posterior aspect, and some of its contents are thrust through into the extra-peritonæal connective tissue. The chief evidence of these accidents is: though the swelling has disappeared, perhaps completely, this has taken place without the characteristic jerk or gurgle. On close examination, though the bulk of the hernia is gone, some swelling, often tender, is usually to be made out, deep down, in the neighbourhood of the internal ring. Above all, the symptoms persist, perhaps in an intensified form.

The treatment is immediate exploration of the inguinal canal and the internal ring. If the cord is exposed, the whole sac has probably been detached. If any of the sac is left above, a rent in it should be sought for. Supposing the index finger, passed through the internal ring, fail to find any swelling, aided by pressure from above, a vertical incision must be added to the upper end of the oblique one, and the neighbourhood of the internal ring explored.*

III. *Retained Testis simulating Hernia.*—Such a testis, when inflamed, or twisted on its mesorchium, which is often long enough to allow this, may closely simulate strangulated hernia. A testis, perhaps, has never descended; a truss has been worn and laid aside. The patient presents himself with a tender swelling in one groin, with indistinct impulse. The abdomen is tense and full, constipation is present, and perhaps vomiting of bilious fluid. Such a swelling should be explored and the testis removed, as it is certain, later on, to cause serious trouble, even

* As this will probably involve abdominal section, the steps given later should be referred to,

if the present urgent symptoms subside with palliative treatment. In other cases a retained testis may draw down an adherent loop of intestine which may become actually strangled.*

STRANGULATED UMBILICAL HERNIA.

Two distinct forms of strangulated hernia will be met with here. One, more rare, is of small size, with a single knuckle of intestine acutely strangled in the navel-cicatrix. The other, the more common, is often huge, its contents mixed, intestine both large and small, and omentum. Such herniæ soon become, in part at least, irreducible; when in this condition, any unwise meal may readily bring about obstruction, a condition requiring much care to tell from strangulation.† In other cases a large irreducible hernia may easily become strangulated from the descent of some additional loop of bowel. The adequate fitting of a truss is often a matter of much difficulty here, owing to the large size of the abdomen, the presence of adherent omentum, and, frequently, of an habitual cough.

Practical Points before Operation.—(α) The sac usually communicates directly with the general peritonæal cavity by a large opening. (β) The contents are not only mixed, but of long standing, and often adherent. (γ) The patients are often advanced in life, obese, flabby, and not infrequently the subjects of chronic bronchitis. (δ) The coverings are ill nourished and slough easily.

Operation.—In view of the delicacy of the skin and the intertrigo which is often present, the cleansing must be thorough but gentle. An anæsthetic having been administered, a curved transverse incision two to three inches long is made across the lower‡ aspect of the *neck of the swelling*, the hernia being pushed upwards to facilitate this.§ The coverings are much thicker and more easily distinguished here than over the fundus of the hernia, where it is easy to injure the contents. Moreover

* For fuller information on these matters I would refer my readers to *The Diseases of the Male Organs of Generation*, chapter ii. p. 72.

† Amongst the most important points will be the vomiting, whether early in onset, constant, and showing signs of becoming fæculent, and the constipation, whether absolute, even to the passage of flatus. In doubtful cases the rule should be to operate. "The risk of operating on a hernia which is inflamed and not easily reducible is very small in comparison with the risk of leaving one which is inflamed and strangulated; and even if you can find reasons for waiting it must be with the most constant oversight, for an inflamed and irreducible hernia may at any time become strangulated, and will certainly do so if not relieved by rest and other appropriate treatment" (Sir J. Paget, *loc. supra cit.*, p. 106).

‡ The lower part is here recommended because, in Mr. Wood's words (*Intern. Encycl. of Surg.*, vol. v. p. 1165), "the point of strangulation in an adult umbilical hernia is most frequently at the lower part of the neck of the sac, where the action of gravity, the dragging weight of the contents, and the superincumbent fat, together with the pressure and weight of the dress or an abdominal belt, combine to press downwards upon the sharp edge of the abdominal opening. It is here that adhesions and ulceration of the bowel are most frequently found, and here the surgeon must search for the constriction in cases of strangulation." An incision here also gives better drainage.

§ If the surgeon intends to attempt a radical cure, and if the skin is diseased, much thickened with old abrasions, he should remove this area by two elliptical incisions,

the contents are rarely adherent at the very neck of the rupture. Search should be made for any constricting bands of fibres outside the sac. The sac must be opened, with the knife held horizontally, and slit up, care being taken now and throughout the operation, in cases of large herniæ, that protrusion of intestine be prevented by the means given a little later. The contents having been examined, any intestine is gently displaced upwards, while the surgeon turns the curved surface of a Key's director over the lower edge of the opening, and, guiding the hernia-knife on this, divides the constricting edge downwards. If sufficient space is not given, the downward nick may be repeated, or the director turned against the lateral or upper aspects of the ring, and fibres here also divided.

Adhesions of the contents of the sac are not infrequently met with. If they are very close and dense, and if the condition of the patient is unsatisfactory, and if the surgeon be short-handed, he should be content with a free division at one or two places of the constricting ring, and with reducing any portion of intestine that has clearly only recently come down, and leave the rest undisturbed.

A complication of large umbilical herniæ is thus well described by Mr. Wood (*loc. supra cit.*, p. 1168):

"In corpulent persons, in whom the operation has been delayed until peritonitis has begun, the operator has frequently to contend with a rush of bowels out of the abdomen. This should be restrained by receiving them in warm towels* wet with carbolic lotion, and applying pressure by the hands of assistants. If it can be managed, all the operative proceedings within the sac should be done before such a rush occurs; but if a cough, or vomiting, or anæsthetic difficulty occurs at this juncture, this is sometimes impossible, and the surgeon is compelled to do the best he can. In such cases the operation becomes a formidable one indeed, and is comparable only to laparotomy under conditions of distension of the intestines. The bowels and omentum should always, if possible, be kept in the warm wet towels, and not indiscriminately handled by the assistants, whose arms should be bared and well purified with carbolised lotion. The intestines should always be returned before the omentum, which should, if possible, be spread out† over them before the stitches are applied."

All the intestine and the remains of the omentum, carefully ligatured, having been returned if possible, the surgeon now, if the patient's condition admits of it, removes the redundant sac and skin by joining the ends of the first incision by another one passing across the upper aspect of the neck of the rupture. The opening into the abdominal cavity is closed in the following manner:—The sac is carefully separated all round till its neck is cleared, the redundant part is cut away, and the peritonæum closed by means of a continuous suture of fine silk. The operation is completed by rapidly performing one of the operations for radical cure which are described on p. 101. Mayo's operation is simple,

* Large squares of iodoform gauze wrung out of hot sterile salt solution are to be preferred.

† Mr. Wood prefers leaving the edge of the omentum so arranged as to become adherent to the lower margin of the hernial opening, so as to prevent, if possible, any future protrusion, to tying it and cutting it short.

and probably for the best. In some cases the edges of the recti may be quickly exposed and sewn together without much difficulty. Attempts to draw the edges of the fibrous ring together without the aid of flaps are to be condemned, because the sutures are very apt to tear out even during the operation, and much more so during the vomiting that follows the operation.* The writer remembers two cases in which re-strangulation occurred from this cause.

It will be seen from the above account that two methods may be pursued in the reduction of a strangulated umbilical hernia: (1) If the surgeon be short handed and the hernia very large or the patient's general condition grave, the ring is freely divided at one or two points, but the contents disturbed as little as possible, any recently-descended intestine being returned, but thickened omentum and adherent intestine (especially large) being left undisturbed. (2) Free opening of the sac, examination and separation of its contents, return of all intestine, and of omentum after ligature and excision of some of the latter.

While the second of these courses has the great advantage of leaving the patient permanently in a more satisfactory condition, as it admits of a radical cure, the surgeon can only rightly decide between this and the first course by a careful consideration of each case. The following points may aid in judiciously selecting either operation:—(1) The size, long standing, previous attacks of incarceration and obstruction of the hernia, all these tending to bring about adhesions and alterations in the parts. (2) The condition of the patient—viz., the degree of flabby fatness, chronic bronchitis, probable renal and hepatic disease, amount of depression by vomiting and pain. (3) The presence of the skilled help so essential in these cases. (4) The way in which the anæsthetic is taken. (5) The amount of experience of the operator. Thus a hospital surgeon, frequently operating and with all instruments and assistance at hand, may readily incline to one course, while the other may as wisely be followed by a surgeon who has to operate under very different circumstances.† For a consideration of the treatment of damaged intestine, *vide* p. 47.

STRANGULATED OBTURATOR HERNIA.

This form of hernia has occurred too frequently to be entirely passed over. It may be so readily and fatally overlooked that a few words on its *diagnosis* will not be out of place.

(1) Position of the swelling. This appears in the thigh below the horizontal ramus of the pubes, behind and just inside the femoral

* Mr. Barker (*Brit. Med. Journ.*, 1885, vol. ii. p. 1101) advises the use of a double row of sutures—the first, to unite the edges of the ring; the second, to give extra strength to the scar, are passed through the anterior layer of the sheath of the rectus on each side, at about one-third of an inch from the edge of the ring. On these being brought together, a considerable fold of fibrous tissue is inverted and brought into contact in the middle line, over the first row which closed the ring.

† Mr. Clement Lucas (*Clin. Soc. Trans.*, vol. xix. p. 5) advocated more radical measures, such as excision of the sac and redundant skin, with suture of the ring, in all cases of umbilical hernia. Two successful cases are recorded, both excellent instances of this treatment, and one of especial interest, as the patient had been previously thrice tapped for ascites, and the operation allowed three pints and a half of fluid to escape.

vessels, behind the pectineus, and outside the adductor longus. (2) On careful comparison of the outline of Scarpa's triangles, a slight fullness is found in one as compared with the hollow in the other. (3) Pain along the course of the obturator nerve, down the inner side of the thigh, knee, and leg. (4) Persistence of symptoms of strangulation, the other rings being empty or occupied by reducible hernia. (5) A vaginal or rectal examination. In making these examinations in cases of intestinal obstruction, care should always be taken to examine the pelvic aspect of the obturator foramen.

Operation.—Two different ones present themselves: (i.) by cutting down on the sac, as in other herniæ; (ii.) by abdominal section, and withdrawing the loop from within.

(i.) The parts having been duly cleansed and slightly relaxed, an incision is made parallel to and just inside the femoral vein.* The saphenous opening being probably exposed in part, the fascia over the pectineus and the fibres of this muscle having been divided transversely for one and a half or two inches, the obturator muscle covered by its fascia and some fatty cellular tissue is next defined, and the hernial sac probably now comes into view, either between the muscle and the pubes, or between the fibres of the muscle. The sac must be opened, and if any constriction has to be divided, the knife should be turned either upwards or downwards, the latter being the easier if any constricting fibres intervene between the sac and the bone. As the obturator vessels lie usually on one side or the other, a lateral incision must be avoided.

Care must be taken to keep the femoral vessels drawn outward with a retractor, while any branches of the obturator or anterior crural nerve are drawn aside with a blunt hook, the same precaution being taken with the saphena vein.

When by the passage of the little finger into the abdomen it is certain that the intestine is reduced, if the condition of the patient admits of it, the sac is separated and ligatured close to the thyroid foramen and removed. Drainage must be provided with aseptic horsehair or a fine tube.

(ii.) The operation of abdominal section will, perhaps, be more frequently performed in the future.

An obturator hernia was thus reduced by Mr. Hilton in a case which simulated intestinal obstruction. Some empty intestine being found and traced downwards, led to the detection of an obturator hernia, which was reduced by gentle traction aided by firm pressure made deeply in the thigh. The patient, who was not operated on till the eleventh day, died of rapid peritonitis.

Sir J. E. Erichsen briefly mentions a case operated on by this means in 1884 by Mr. Godlee. The hernia was reduced without difficulty, but the patient, who was much collapsed at the time, died in about twenty-four hours.

Question of the advisability of reducing Strangulated Hernia by Abdominal Section.

This question having arisen here may be dealt with once for all.

* Mr. Birkett (*loc. supra cit.*, p. 830) says the incision "may commence a little above Poupart's ligament, at a point midway between the spine of the pubes and the spot where the femoral artery passes over the ramus of that bone."

Cases will occur from time to time, such as Mr. Hilton's (*loc. supra cit.*), in which, evidence of acute intestinal strangulation existing and no hernia being detected externally, on the abdomen being opened the cause will be found to be a piece of a small intestine nipped in part of its circumference, probably in either one of the femoral or obturator rings. Still more rarely, a surgeon may find such difficulty in reducing an obturator hernia from without, that he feels himself driven to resort to abdominal section. More frequently he may find the bowel gangrenous in an obturator hernia. It is to be remembered that the rupture is often a partial enterocele with dubious symptoms which have delayed treatment. If the patient's condition be fairly good, resection is then indicated, and can only be performed through a laparotomy wound. An incision should be made through the corresponding rectus low down, the Trendelenberg position adopted, and the limbs of the loop of bowel which are within the pelvis clamped with Doyen's intestinal forceps. The constriction should then be divided in a downward direction, and the strangulated intestine withdrawn into the pelvis and then out of the abdomen, where it can be thoroughly examined and resected if necessary. Should the sac be suppurating it can be drained through a wound in the thigh. Some years ago it was suggested that it should be the rule to reduce herniæ generally, and to perform the radical cure by abdominal section. Thus at the meeting of the British Medical Association in 1891 (*Brit. Med. Journ.*, Sept. 26, 1891), this question was discussed, the late Mr. Lawson Tait introducing the subject. As might be expected, the proposal to abandon the old operation and treatment by median abdominal section met with no support from those surgeons who know anything of operations for strangulated hernia in hospital practice, especially in males. Save in the rarest cases, such as those belonging to the category I have mentioned, such a step is to be condemned in the strongest terms, for the following reasons: (1) Operations for relief of strangulated hernia must sometimes be performed by general practitioners. The old and well-established operation is one, *per se*, of but slight severity, and one that usually can be kept extra-peritonæal by an operator of ordinary skill and of average anatomical knowledge. Those who would substitute abdominal section forget that, however safe they may consider themselves, with their especial experience, to be in preventing *peritonitis*—a very different standpoint from that of a general practitioner—neither they nor anyone else can prevent the *shock* which goes with intra-peritonæal operations, a complication which is certainly to be avoided in patients exhausted by a strangulated hernia. (2) The reduction of the intestine which is spoken of as so easy after abdominal section by those who advocate this method, is liable to be prevented by adhesions to the sac, &c.; when such exist—and no one can foretell this point—the sac must be explored in the usual way. (3) There is a very grave risk that the intestine is tightly nipped, and often may give way when pulled upon through a median incision. Those who advocate abdominal section will say that the resulting extravasation can be met by flushing, &c. It will be well for all such to remember the following advice, tersely put by Sir W. Bennett (*Clin. Lect. on Hernia*, p. 122): “Let it be noted that it is generally far more easy to *soil* the peritonæum than to *cleanse* it.” The same surgeon points out (*ibidem*, p. 121) that

the fluid found in the sac of herniæ, when strangulation has long existed, is sometimes dark and ill-smelling, though no lesion may be apparent in the gut itself. By an ordinary herniotomy such fluid is thoroughly drained away from the peritonæal cavity, and any such intestine is cleansed before it is put back, or otherwise appropriately dealt with. (4) All operating surgeons are agreed that, whenever the condition of the patient admits of it, an operation for strangulated hernia should be completed by giving the patient at least a chance of radical cure. I am distinctly of opinion that no intra-peritonæal operation yet described will secure radical results in inguinal herniæ. (5) Those who think they are improving matters by substituting abdominal section for the old-established herniotomy, object to the latter on account of its tendency to weaken the abdominal wall by the incision made to reach and relieve the constriction. Such advocates forget the criticism pithily put forward during the above discussion by Mr. Keetley, that treatment of herniæ by abdominal section created two potential hernial apertures where there was originally but one.

RADICAL CURE OF HERNIA.

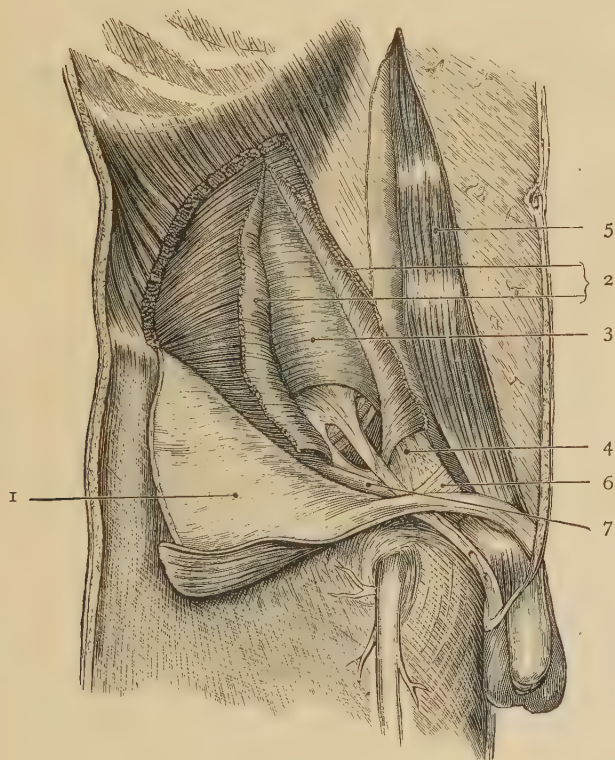
Before describing the different methods, the following points claim attention; and while the improvements of modern surgery have established radical cure on a sound scientific basis, many questions remain still undecided. The chief of these are: (1) the mortality of the operation. (2) The use of the terms "radical cure" and "permanency of the cure." (3) The earliest age at which the operation is advisable in children. (4) The advisability or need of wearing a truss afterwards. (5) The best material for suture. (6) The best form of operation.

(1) **The Mortality of the Operation.**—The following statistics show what modern surgery and experienced hands can do. Drs. Bull and Coley (*Ann. of Surg.*, vol. xxviii., 1898, p. 604) have compiled a list of 8594 cases, under the care, be it noted, of well-known operators, with seventy-eight deaths, giving the very low mortality rate of '9 per cent. The same writers in a later publication (*Ann. of Surg.*, June, 1903) publish an analysis of 1095 of their own cases, with a mortality of only two—less than '2 per cent. One of these died of ether pneumonia. Since these deaths Coley has performed 500 radical cures without a death. These authors also quote the mortality at Carle's Clinic in Rome as only two in 1400 operations; and at the Johns Hopkins Hospital, where an extensive operation is employed, at one in 459. Bull and Coley (*Med. Rec.*, March 18, 1905) publish a mortality of only '3 per cent. in 1500 radical cures in children, mostly over four years of age.

(2) **The Value of the Term "Radical Cure," and the Permanence of the Cure after Operation.**—Some years ago Mr. Macready, surgeon to the City of London Truss Society, wrote the following weighty words on what he called the unsatisfactory nature of the evidence as to efficacy of the radical cure (*A Treatise on Ruptures*, p. 234): "The evidence brought forward by one surgeon after another in favour of these operations is always of the same character. A number of cases are given in which the operation has been performed, and in which the result has been watched for periods varying usually from a few

months to four or five years. Very few cases are under observation so long as five years; for the patient changes his residence or declines to show himself. M. Terrier on one occasion wrote to twenty-five old patients, and received only two replies. It must not be supposed that a patient is cured because he does not come for inspection. The relapsed cases at the Truss Society have almost all been asked if they have visited the operator to show him the result. In the great majority of cases they prefer not to go back, and very often, alas! express themselves as if a

FIG. 10.



Dissection of inguinal canal.

- 1, External oblique turned down. 2, Internal oblique. 3, Transversalis.
 4, Conjoined tendon. 5, Rectus abdominis with its sheath opened.
 6, Triangular fascia. 7, Cremaster. (Heath.)

deception had been practised upon them. It is much to be regretted that patients should feel this reluctance to face the operator again, for in consequence the surgeon is apt to form too favourable an opinion of the efficacy of his plan. Sometimes a patient, after remaining cured for a number of years, passes from under observation and again becomes ruptured. . . . All that we can say of the operations, involving complete removal of the sac, is that they all give immunity to a certain number for a certain time."

Since Macready wrote these melancholy words, things have changed and improved greatly; but some of his warnings are still to be

remembered. Surgeons are still too apt to claim their results as radical cures after a few months or a year.

In recent years we have learnt more distinctly the principles on which this operation is to be conducted. Two or three methods have now been employed on such a large scale, and with such excellent results, that it seems probable that a permanent cure can be promised in a large number of favourable cases. This qualified statement requires explanation. By a "permanent cure," I mean a cure which will last a lifetime. By "favourable cases," I mean children, young subjects, herniæ of moderate size, where the rings and canal are still present and not stretched and converted into one large direct gap into which the tips of two or three fingers can be easily placed; cases where the patients operated on have sense enough to give the newly repaired structures sufficient rest for their consolidation, and where, if they must follow employment or exercise that involves much straining, they will give the parts the support of a truss of light pressure or a belt* (*vide infra*). If this is not done we shall see, if cases are carefully followed up and candidly reported, that radical cures will not last a lifetime, and that the term will have to be largely replaced by the following, according to the degree of cure obtained—viz., "complete successes," "partial successes," "complete failures."

Since Bassini published, in 1888, the description of his operation, this method, either as first described or modified in some slight degree, has become more and more popular, and, at the present time, its adoption may be said to be almost universal. Dr. Coley (*Ann. of Surg.*, June, 1903) published an account of 1000 operations for inguinal and femoral herniæ performed between 1891 and 1902; 937 of these were inguinal and 66 femoral. In 917 inguinal operations by the Bassini method there were only 10 known relapses, or a little over 1 per cent.; but these cases were not all traced for long enough time. Thus out of the total 1003 cases 647 were traced and found well from six months to eleven years, 410 were well from two to eleven years. There were six relapses in 20 cases of inguinal hernia in which the cord was not transplanted. In 181 cases of inguinal hernia in women there were no relapses and no deaths; the round ligament was not transplanted in these. Coley gives statistics to prove that patients very rarely get recurrences after one year; over 90 per cent. of the relapses appear in the first year.

It may be said, therefore, that after one year the chances of relapse are not great, although no absolute time limit can be given after which cure may be said to be absolute. Jonathan Hutchinson, jun. (*Lancet*, 1906, vol. i. p. 903), gives a very valuable and candid account of the results of his own cases at the London Hospital during the last fifteen years. Out of 360 operations for radical cure of inguinal hernia, he was able to trace 100 for over two years,

* Many will say that if any truss or support is worn afterwards the cure is not radical; I admit this, but reply that until published series of cases have been watched for a much longer period, we shall, as relapses may occur five or eight years after operation, do wisely to advise the above class of patients to support the restored region with a well-fitting truss of light pressure, and so bring about a permanent cure instead of a liability to relapse.

the average being traced for six years. There were eight relapses, five pronounced, one very slight, and two doubtful relapses, having only a slight bulging at the site of the hernia. In five of the relapsed cases the sac had been twisted and displaced, but the canal had not been sutured.

In only two had Bassini's method been used and MacEwen's method in one case. It is interesting to note that seven of the 100 cases had developed some other hernia.

Bull and Coley (*Med. Rec.*, April 18, 1905) publish an account of 1076 operations on children after Bassini's method, with only six relapses, but mention five relapses in 125 operations performed about 1892 by other methods.

It is very striking to notice that in nearly all the relapsed cases some suppuration had occurred, and this is no doubt the main cause of the relapse; a severe cough is another, especially if present during the first few weeks after the operation.

From the above it is clear that, when consulted as to the performance of a radical cure by patients the subject of hernia, they can be assured as to the safety of the operation and the probable permanence of the cure in favourable cases (*vide supra*). In the practice of experienced and aseptic surgeons the mortality ought not to be more than .5 per cent., and the recurrences should be considerably under 5 per cent. Furthermore, it is certain that if a relapse should occur the majority of patients will be better off than before the operation. The protrusion that appears will be smaller than the original rupture, more readily kept within bounds like a bubonocoele, and a truss will be worn with greater comfort. On the other hand, if suppuration occur, and a thin-walled feeble cicatrix, sure to yield increasingly as years go on, is the only result, the outcome of the operation may leave the patient worse off than he was before.

A question that often arises relates to the wearing of a truss and the possibility of the hernia being cured by this means alone.

The answer deciding between the wearing of a truss and an operation for radical cure will depend greatly on the mind of the surgeon consulted. If he is one of those who believe that this operation is too indiscriminately resorted to, he will hold that no operation, save for special reasons (*vide* Indications for Operation), is to be advised where the hernia can be kept up by a truss, and that a light and well-fitting truss is not the bugbear it is too often made out to be by those who advocate operation as the rule. It would be well if surgeons would spend some of that pain and trouble in ensuring that the truss fits, before it is thrown aside, which they give to inventing or modifying operations for radical cure, and if patients would exert a little more trouble and pains in getting a proper and well-fitting truss at a duly qualified instrument-maker's, instead of the first cheap trash which they see in a chemist's shop. I have pointed out below, under the heading Indications for Operation, the cases where this question of wearing a truss does not arise.*

When this question, whether the wearing of a truss will effect a

* An ill-fitting truss is, of course, worse than useless, and may mat together the tissues.

radical cure, arises in the case of infants and children, these cases may be divided into the following groups. In one—and this is the largest of the three—the careful wearing of a truss by a child will permanently cure the rupture. In a second group—a large one—the hernia, though not cured, will be perfectly controlled with very slight inconvenience to the patient. In the third—a small one—there is no tendency to spontaneous cure even when a suitable truss has been diligently worn. Very large herniæ, and especially those containing the cæcum, which may be irreducible, belong to this class. With the very small mortality of the present day and the few recurrences, surgeons attached to children's hospitals operate more and more frequently. It is very difficult to keep the children of the poor supplied with new trusses often enough to render them effectual. If the truss break or be left off and the hernia descends, the work of years is undone, and strangulation may occur at any time. Again, a number of patients supposed to have been cured by trusses in infancy have a return of their trouble in adolescence, or early manhood.

Mr. Hamilton Russell (*Lancet*, vol. i. 1905, p. 7) even believes that all the oblique inguinal herniæ of adults have descended into congenital sacs. We agree with Mr. Russell that a large majority of the so-called acquired herniæ of adults have congenital sacs of the incomplete or funicular type, but we do still believe in the existence of acquired inguinal hernia.

Mr. Murray (*Lancet*, vol. i. 1906, p. 363) adduces several arguments in support of Mr. Russell's views, and shows that in 100 autopsies potential hernial sacs were found in 21 cases; 13 sacs occurred in 61 males, and 8 sacs in 39 females.

On this follows naturally the next question: (3) **What is the earliest age at which an operation should be performed?** Below I have stated my opinion that while it is occasionally justifiable to operate in the second year of life, where a persisting hernia is large, it is, as a rule, better to defer operation till the age of four or later.

Bull and Coley (*Med. Rec.*, March 18, 1905) operate on about one in ten of the children that come to their out-patients seeking treatment for hernia, but they rarely operate without trying a truss for one or two years, and rarely under the age of four years. They advise operation in the worst of the cases over four. They also perform a radical cure in all cases of (1) strangulated hernia, and cases of strangulated hernia, which have been reduced by taxis some days before; (2) irreducible hernia rare in children; (3) hydrocele of a hernial sac; (4) the rare cases of femoral hernia in children—they regard these as incurable by truss.

Stiles (*Brit. Med. Journ.*, Oct. 1, 1904) gives the results of 360 operations for hernia in infants and young children, with five deaths and only four recurrences.

For the reasons given above, surgeons now frequently operate ON POOR CHILDREN under the age of four, and with results at least as satisfactory as those obtained in older children and adults.

(4) **The Advisability or Need of wearing a Truss afterwards.**—The tendency of the present day to condemn offhand or to deprecate strongly the use of a truss after an operation for radical cure is, I think, a great mistake. Each case must be judged separately. With regard

to children, from an experience of my cases, I think that if the recumbent position be insisted on for three months after the operation, so as to give the newly restored parts time to consolidate firmly, a truss will not be subsequently required, so great is the tendency to repair in early life. Umbilical herniæ I am inclined to make an exception. The communication which has here been closed has been relatively so large, the stress thrown upon it after repair in expiratory efforts (as when the child cries every time at the approach of the surgeon or dresser during the after-treatment) is so direct, that the scar should, I think, have support for some time in the form of a well-fitting belt.*

In adults the objection usually made to a truss is that its pressure will produce absorption of the scar. While it will be granted at once that any continuous pressure in the form of a pad with a strong spring will tend to weaken and remove the inflammatory thickening resulting from the operation, I am distinctly of opinion that some well-fitting slight support in the form of a flat-bladed truss or belt should be worn in the following cases—viz., where the abdominal walls are very fat, flabby and pendulous; where there is heavy work either done continuously or by fits and starts; where any silk has worked out, or where the wound has healed by suppuration (*vide supra*, p. 65); in some cases where the radical cure has been done after an operation for the relief of strangulation, and the surgeon has perhaps been hurried, or has operated at night; and, of course, in cases where there is any return of the hernia. Other cases are umbilical herniæ, both in adults and children, for the reason I have given above; in some cases of femoral hernia in which the crural ring has been very large and difficult to close in stout patients; moreover the sex and dress of the patient usually make the wearing of a truss less irksome. On the other hand, in early congenital cases, in boys, in young adults without laborious work, or where the reparative power is good, where sufficient rest has been taken after the operation, and where primary union has been secured and remains firm, no truss need be worn. But the importance of intelligent supervision at intervals should be insisted upon.

The presence of a cough, carelessness about constipation, or a stricture will, of course, be duly weighed; and I may remind my readers of a warning uttered at p. 63, that relapse may take place as late as four or even eight years after a skilfully performed operation.

On the other hand, it is only fair to say that the opinion on this matter expressed by others is widely divergent on some points from that given above. For instance, Drs. Bull and Coley (*loc. supra cit.*) say: "Personally we never advise a truss in children after operation, and we consider the recumbent position for three months entirely unnecessary. Our experience, based on a series of upwards of 600 cases of hernia in children under fourteen years of age, has shown that two, to two and a half weeks is ample time for the child to remain in bed. The subsequent history of these cases has been traced with scrupulous care, and some of them have been well upwards of seven years. Even in adults we very seldom advise a truss after operation. There are, however, some cases in which a permanent cure will be more likely to be obtained if a support

* Any phimosi or cough should, of course, be treated.

be worn after operation. Such cases are those beyond middle age, with poorly developed and flabby abdominal muscles and a superabundance of fat. We would also include cases in which the hernia is of unusual size in adults past middle life."

Lockwood (*Hernia, Hydrocele, and Varicocoele*), again, does not order a truss after operation, except in cases in which some support is specially called for. He says: "So far as I can see, it is time enough to order a truss when signs of recurrence appear. After radical cure has been done, relapse seldom occurs suddenly. When the sac has been thoroughly obliterated by the operation, the hernial protrusion has to make for itself a new one; this is usually a slow process and accompanied by pain from the beginning." This practice is clearly justified by results, for Lockwood's list of cases shows only five relapses in ninety-one cases, in periods varying from six months to seven years. It may be noted, also, that in each of these five cases the relapse occurred within twelve months.

(5) **The Best Form of Suture.**—Surgeons still hold different views upon this point. The ideal suture should be aseptic, absorbable, supple, and strong. Silk is most satisfactory to work with at the time; it can be obtained at once, it is soon sterilised, it is strong, and it lends itself readily to easy tying and a secure knot. But the after-result is, in my opinion, less satisfactory, owing to its liability to come away, often persistently. There is a tendency to believe and teach that wherever silk comes away after an operation, it must always be due to some deficient sterilisation of the silk, or to some failure to keep the wound aseptic. While these are leading causes, they are not, I am persuaded, the only ones; the site and the character of the tissues concerned play a very important part. Inside the peritonæal cavity, where the ligature lies deep and is surrounded by a serous membrane, as in an ovarian pedicle, we are certain our silk ligature will give no trouble; in ligature of the carotid or femoral artery, where the ligature also lies deep and is surrounded by vascular structures, we have rarely trouble with our silk ligatures; but here, where any silk used lies comparatively superficially and embedded in fibrous tissues such as the conjoined tendon or Poupart's ligament, its surroundings are so different that a surgeon need not always blame himself for deficient asepsis or faulty tying when his silk comes away. In a certain and large proportion I know from experience that silk can be used, but in a considerable number this and the other materials most certainly cause trouble later on. The wound runs an aseptic course, heals without suppuration, and then, after a varying period, up to several years sometimes, a sinus appears, and one or more of the sutures have to be removed. Drs. Bull and Coley, in the papers referred to above, used kangaroo-tendon chromicised enough to resist absorption for from four to six weeks, and though the interval between the date of operation and that of publication is in many of them far too brief for the cure to deserve, in my opinion, the term "radical," the constancy with which primary union was secured speaks very strongly, I think, for the use of kangaroo-tendon in preference to silk. Catgut can also be prepared in a similar way and is certainly preferable to silk. Hutchinson (*loc. supra cit.*) also strongly recommends kangaroo-tendon because it is strong, supple, and non-irritating, and can be kept for years without deterioration in an alcoholic solution of carbolic acid.

Prof. Macewen in his address on Surgery at Oxford (*Lancet*, Aug. 6, 1904), discusses the advantages and disadvantages of the various suture materials very fully. He points out that it is not enough to secure an aseptic ligature, but that it is necessary to select one that is absorbed after its work is done in about three weeks. He also draws attention to the important fact that non-absorbable sutures are incapable of *holding living structures together for more than a few weeks*. "After a period of twenty-one days the continued traction of the suture causes the soft tissues to give way before it. And this goes on until the suture lies loose and functionless in their midst." The tissues within the grip of permanent sutures of silk, wire and salmon-gut become gradually absorbed even without any suppuration, and this clearly leaves the sutured area much weaker than after the use of an absorbable suture like catgut, which does not induce nearly so much of this quiet and aseptic necrosis of the tissues if care be taken not to tie it too tightly.

Macewen strongly condemns the use of wire sutures, and relates five cases of inguinal hernia in which gold wire had been employed by other surgeons. Three of these came to Macewen for recurrence of the hernia and the two others for strangulation of the bowel by the loops of wire. In one of these, perforation of the bowel had already occurred at the site of constriction by the wire.

Macewen states that kangaroo-tendon does not get absorbed for months, and Hutchinson has found some of his sutures to remain unabsorbed for over two years.

Macewen prefers catgut to all other materials for sutures, and the following remarks are quoted from his address:

"Catgut is one of the best substances generally available for sutures and ligatures, but care ought to be exercised in choosing good material. For ligatures and sutures raw catgut ought to be selected, preference being given to such specimens as present the best physical properties and show that care has been bestowed on its manufacture. It must be evident that the subsequent preparation does not remedy physical defects originally in the gut, such as want of strength or roughness. When the catgut is selected it is then placed in a solution prepared for the purpose of increasing the resistance offered by the gut to the action of the living tissues. As the resistance required varies according to the use to which the catgut is to be put, so the catgut is prepared with various degrees of resisting power, some hanks for rapid absorption and some capable of resisting the action of the tissues for longer periods. The gut must not be hardened in such a manner as to prevent leucocytal penetration, otherwise it will be too resistant and in this way may be no better than silk or wire. Experiments have been made in many directions with the view of obtaining a suitable medium for the preparation of catgut so as to obtain the objects in view. One of the best media which we have used is obtained by adding an aqueous solution of chromic acid to glycerine in definite proportions. This compound is found to act upon the catgut in the way of increasing its resistance to the action of the living tissue. Though producing a soft, pliable catgut, the degree of resistance imparted to the gut can be varied according to the time which the gut is immersed in the solution. The longer it is kept in the solution the more resistant it becomes. After it has thus been prepared it is stored in a carbolised

glycerine solution. It is ready for use a fortnight after it has been introduced into the storage solution. When kept in this storage solution for a longer period—many months or several years—it becomes slightly more resistant to the tissues."

It seems to us that the choice lies between chromicised catgut and kangaroo-tendon. The latter is stronger but more expensive. Suppuration, late stitch sinus, and recurrence of the hernia is less common with these materials than with any of the permanent sutures.

I use catgut which has been sterilised by boiling in xylol, or by the action of iodine.

WOUND HEALING.

The mortality and the relapses after radical cure of hernia depend more upon the occurrence of suppuration than upon anything else, therefore it is of the utmost importance to prevent the slightest suppuration.

With modern precautions in sterilising sponges, instruments and sutures, the most frequent sources of infection are :

(1) **The Hands of the Surgeon** and his assistants; the risk of infection from these can be greatly diminished by the wearing of boiled rubber gloves by all concerned. It must not be forgotten, however, that the gloves may be easily contaminated in putting them on or by touching the patient's skin. The hands must be cleansed as thoroughly as possible before putting the gloves on, for the latter may be accidentally pricked during the operation and the wound thus infected from the operator's hand.

Bull and Coley (*loc. supra cit.*) had 4·4 per cent. of suppurations, in 567 early cases before the use of rubber gloves, and only 2·1 per cent. in 933 later operations. This difference is no doubt partly due to the increased experience of the two operators, and also to improvements in their technique in other respects, such as reducing laceration and bruising of the tissues to a minimum. The danger from the hands can also be lessened by abstaining from all handling of the tissues, and sponges, and doing all the work, even the tying of sutures with the aid of instruments. Sutures are often infected by forcibly dragging them into the skin of the fingers in tying. The writer has had no suppuration in any case in which he and his assistants have worn gloves in the last two years.

(2) **The Patient's Skin.**—That this risk is considerable even with much care in scrubbing and compressing is evident from the following facts: Bull and Coley (*Med. Rec.*, Mar. 18, 1905) :

"A careful bacteriological examination of some fragments of skin taken from the field of operation just prior to the making of the incision was made by Dr. M. Jeffries, in 290 cases, with the following results :

Total number of skin cultures	...	...	...	290
Number of instances in which growth was obtained	...	...	...	27
Per cent. not sterile	...	...	...	9·31
Streptococcus obtained	...	...	...	7 times
" " "	...	...	...	2·41 percent.
" " alone	...	...	...	4 times
" and a diplococcus	...	...	...	2
" " tetrad	...	...	...	1
Micrococcus tetragenous	...	...	...	10

A diplococcus	...	...	...	...	...	6
Tetrad and bacillus	...	...	...	...	...	1
Bacillus alone	...	...	...	...	...	2
Staphylococcus and a bacillus	...	...	...	...	...	1."

Suppuration occurred in 33 per cent. of Bull and Coley's cases, that is, in 47 out of 1,424 operations. It was very slight and superficial in 35 of these.

This source of infection can be minimised by fixing aseptic pieces of lint to the very edges of the wound, so that none of the patient's skin is exposed, and sutures, sponges, or gloved fingers cannot convey any infective scales from it into the wound.

If the above precautions be taken, and all bruising be avoided, and all hæmorrhage arrested, the risk of infection becomes very small.

Indications.—The following are given only as types of appropriate cases. Many others will suggest themselves :

i. Cases of irreducible hernia where other treatment has failed, where an active life is interfered with, or where attacks of inflammation have occurred, or strangulation is threatened. Subjects of inguinal hernia with adherent omentum are never really safe, especially if of active life: from this, however, they are usually debarred. Femoral herniæ containing irreducible omentum should also be operated on. These herniæ are difficult to fit with trusses; the omentum keeps the ring open, and thus paves the way for the descent of bowel on any sudden exertion. Where irreducible herniæ are small, and the adhesions easily separated, great relief will be given the patient with very slight risk. But it is otherwise where the sac is very large, or the contents adherent, especially about the neck of the sac. In either case the risk of the operation is increased, in the one case from the direct opening into the peritonæal cavity which may be present, the large amount of contents which have to be manipulated, and the difficulty of keeping the operation extra-peritonæal. Again, intricate adhesions about the neck of the sac may either lead the surgeon to abandon the operation, or to lay open the abdominal wall in order to deal with them. This last step may bring about, some time later, a hernia very difficult of control, the ultimate improvement in the patient's condition being thus of a very limited nature. The risk of peritonitis, even in these cases, should be very small at the present day.

ii. Cases of strangulated hernia, where the patient's condition admits of the operation being prolonged.

iii. Cases where a hernia is not controlled by a truss, but slips beneath it. Such cases would be extremely rare if patient and surgeon alike showed sufficient pains and patience in securing a well-fitting truss.

iv. Cases of hernia with ectopia testis where the fitting of a truss to keep the hernia up and the testicle down fails. Castration should always be performed when the condition of the testis is useless or doubtful.

v. Cases where the hernia can be controlled by a truss, but the use of this is irksome to a patient of very active life, where he wishes to join the army or navy, or where he may, as a colonist, be far removed from surgical help.

vi. Children of poor, ignorant, and incompetent parents, with large herniæ, where proper attention to the use of a truss cannot be secured,

or where the persevering use of this has failed, and where all such causes as phimosi, cough, &c., have been removed. It will probably be justifiable to go further than this, and to operate for radical cure in most cases of herniæ in the children of the poor in which the hernia is still large at four to six years of age.* By this time the parts are better developed and more easily kept aseptic. The sac is more easily dealt with now than later. The presence of any conditions which call for exploration—viz., hydrocele, adherent omentum, the presence of the appendix—will also be indications for operation in children. On this point, operation for radical cure in little children,† I will quote Mr. Macready (*loc. supra cit.*, p. 256). We may all envy his special experience and strive to imitate his skill. “Uncontrollable ruptures in children under fifteen are very rare; to me, indeed, they are as yet unknown. I hope it does not imply any lack of charity to say that one can measure with fair accuracy a surgeon’s skill in the management of trusses by the number of curative operations he performs on children.”

vii. Large herniæ, even colossal, where the patients, unfitted for work of any kind, are a burden to themselves and others,‡ and perhaps willing to run great risks; for it cannot be denied that these are very grave cases: “The operation usually difficult and prolonged, and the dangers to be met and overcome both numerous and various” (Banks). The chief of these is the direct and gaping communication with the peritonæal cavity and the difficulty in keeping the operation extra-peritonæal. The best proof of this is given by Sir W. M. Banks’ series of sixteen very large and enormous herniæ; of these he lost four, two from septicæmia. In another, even his hands failed to complete the operation.

viii. I consider ten to twenty-five years of age the most favourable time, as combining parts easy to handle, the possibility of keeping the wound aseptic, probable absence of any difficult adhesions, and good vitality and health.

INGUINAL HERNIA.

Choice of Operation. — The following have been brought prominently before the profession, viz.: The operations of Bassini, Kocher, Halstead, and MacEwen. Of these, a modification of Bassini’s operation is by far the best and the most generally suitable operation.

Before describing the different methods mostly in vogue, I will allude, for the sake of my younger readers, to a few points which are always of importance, whichever method is selected.

The thigh being a little flexed, an ample incision is made over the inguinal canal, and extending an inch below the external abdominal ring. This divides skin and fasciæ and several branches of the external

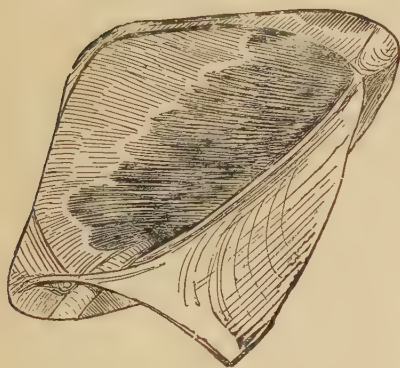
* This age is mentioned above as giving time for sufficient trials with a truss.

† Before deciding that a well-made truss will not keep up a difficult case—*e.g.*, a double inguinal hernia—the hernia should be completely reduced with the aid of an anæsthetic.

‡ As in three cases given by Sir W. M. Banks: one, a labourer, unfitted for work, had become an inmate of a workhouse; the second was a wine merchant, who had been obliged to give up his business, rarely venturing out, and then obliged to conceal his deformity under a large overcoat; the third, a glass-blower, reduced to perfect helplessness, had to depend on his wife for his support.

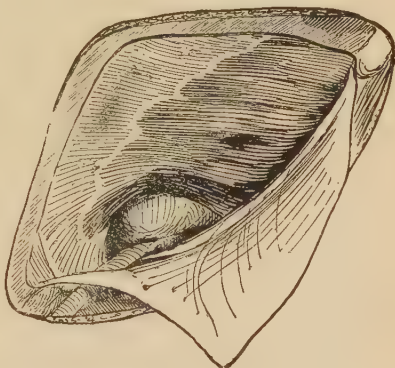
pubic arteries; these should be secured with Spencer Wells's forceps, which will also open out the wound. In young males, especially, where these vessels are of considerable size, care must be taken that each point is firmly closed either by the forcipressure or catgut ligature; otherwise free bleeding may readily take place in the lax tissues of the groin, preventing primary union, and perhaps leading to most troublesome tension and suppuration. The aponeurosis of the external oblique and the cremasteric fascia having been next divided, the site of the cord is made certain of, and the sac most carefully defined. This, if empty, is by no means always easy, especially in young subjects. In defining the sac, care should be taken to work carefully and without any needless disturbance of the parts, or separation of the planes of tissue here met with. So, too, with the cord—great care must be taken in the next step, when the sac and this structure are separated;

FIG. II.



A normal inguinal canal. Arciform fibres compressing the cord against Poupart's ligament. (Lockwood.)

FIG. IZ.



Inguinal canal in case of hernia. The arciform fibres are displaced upwards, the normal valvular condition of the canal being thereby destroyed. (Lockwood.)

hasty work may lead to needless hæmorrhage from ruptured veins, injury to the sac, or subsequent epididymo-orchitis. The sac having been accurately defined, is opened so that the operator may make sure that it is empty; otherwise any intestine is completely reduced or omentum dealt with according to the steps given at p. 44. If the question arise, whether the sac should always be opened, I should answer "Yes." Even if it appear empty below, it is satisfactory to be assured by visual examination that nothing lies within the neck before this is twisted or tied as high up as possible. A case of Busch's (*Klin. Med. Woch.*, 1882, No. 31, p. 473) shows the importance of taking this step.

Operating on a boy 2½ years old for a right inguinal hernia, Busch tied the sac before opening it. When it was cut into below the ligature the vermiform appendix was found included. This was released and returned. Some time later Busch was operating on the left side, and again found that he had included the appendix in his ligature round the sac.

Herniæ with Unusual Contents.—These may be (a) Fat herniæ. Both in the inguinal and femoral regions, but especially in the latter,

the extra-peritonæal tissue near the rings may become increasingly fatty. Gradually projecting towards the surface, it drags down the peritonæum to which it is loosely connected. I have operated on one such case in a girl, aged 19, in whom the fitting of a truss was unsatisfactory. Here I expected to find an omental hernia. Into the pouch so formed intestine or omentum may protrude. In other cases, if the extra-peritonæal fat thus protruded become absorbed, the hollow thus left may produce a space for the peritonæum to project into. (β) *Hernia of the ovary.* This is much more commonly met with in inguinal herniæ. The chief points in the diagnosis of these difficult cases are the characteristic oval shape and size of the swelling; the peculiar sickening pain when the swelling is pressed upon; the swelling being larger and the tenderness greater during menstruation; the swelling may sometimes be made to move when the uterus is displaced laterally with a vulsellum, and the ovary of that side is not to be made out *per vaginam*. Where other treatment has failed, where the swelling is irreducible and prevents the fitting of a truss, where the symptoms are sufficiently urgent to cripple a young life, the displaced ovary should be removed. The operation should be rigidly aseptic. Adhesions are not uncommon. (γ) *Hernia of vermiform appendix.*

I met with a case of this early in 1890, in a lady, aged 43, a patient of Dr. Fraser's, of Romford. The femoral hernia was here irreducible, dull, gave a feel of omentum, and curved upwards and outwards in the usual way. As no truss was satisfactory, and as the patient, the wife of a missionary, was to be much abroad, a radical cure was advised. The sac contained much fluid, but no omentum. In the outer part of the hernia lay a thick fleshy body, tubular and expanded at its end. Near Gimbernat's ligament it was constricted and distinctly abraded. After notching the above ligament this body, which proved to be the appendix, was easily returned. The sac was removed. The case did excellently.

In another case I should remove the appendix if there were time for making the necessary suturing secure. (δ) *Hernia of the bladder.* The viscus may descend either partly or completely covered by peritonæum; in the first and commonest form the bladder may not be recognised until it is wounded, or even until collapse develops, and hæmaturia is discovered some hours later. I know of two cases in which this accident occurred during the radical cure of femoral hernia, and one of the patients died. The bladder protrudes most frequently into an inguinal hernia.

When the emptied sac is next separated from the cord and adjacent parts,* care must be taken, if the patient strain at this time, that no escape of intestine occur, an assistant maintaining pressure over the internal ring. The cord must be treated with the precautions given above, and care must be taken that the testicle is not dragged needlessly out of its bed. The sac is now treated, and the canal closed by one of the methods given in detail below. The wound having been thoroughly dried out, it is closed with sutures of salmon-gut or horse-hair, care being taken that no inversion of the edges is present, and, of far more importance, that all hæmorrhage has been entirely stopped, including those points from which Spencer Wells's forceps have been removed. If absolute dryness of the wound has been secured, and

* If much difficulty is met with here, the surgeon should begin high up, as near the internal ring as possible.

the operation has been aseptic throughout, no drainage is needed. Some strips of aseptic cyanide gauze are then placed next the wound, and covered by any of the antiseptic gauzes or wools. In applying the bandages, it is important to keep the scrotum well up on the pubes, and thus to minimise the risks of œdema of the scrotum and epididymo-orchitis.

To the above general remarks I have only to add that it is always well, when the radical cure is performed in patients with long-standing hernia (with important parts and the sac perhaps very adherent), or a voluminous one, for the operator to obtain leave beforehand to sacrifice the testicle; and the same course will be taken when a retained testicle is found to be probably functionless. If it is worth while to fix this again in the scrotum, this should be done according to the steps given under the heading of Orchidopexy.

Any child or restless patient should be secured in a long outside splint.

The different methods that have been elaborated are very numerous, and only those which are chiefly in vogue at the present time can be described here in full. Brief mention will, however, be made of some of the others. It will be seen, if these various methods be compared with one another, that, whereas most of them are alike in aiming at reconstituting, in some degree, the original valvular condition of the inguinal canal, on the other hand, they differ chiefly as regards the method of dealing with the hernial sac.

Taking the latter point first, it will be seen that the various special methods that have been devised for dealing with the sac aim chiefly at converting the normal depression, or peritonæal fossa, at the position of the internal abdominal ring, into a prominence with its convexity towards the abdominal cavity. Even if the operation does succeed in attaining this, it must surely be only temporary, for, clearly, the sac will rapidly shrink and undergo partial absorption. Moreover, since there is normally a slight depression in this position, and since only a very small proportion of all individuals suffer from inguinal hernia, it is clear that the removal of the depression at the site of the internal abdominal ring is not to be looked upon as the most important part of an operation for the radical cure of a hernia. This contention is borne out by the results of operation, for in Bassini's operation, which is so successful as to be almost considered perfect (*vide* p. 64 for results), the sac is simply ligatured at its neck, and the rest removed, leaving, therefore, a depression in the peritonæum opposite the ligature. With regard to the question of the inguinal canal, it is clear that the normal valvular arrangement (*vide* Fig. 11) of the canal is extremely satisfactory in preventing the descent of an inguinal hernia, since such a very small proportion of all individuals suffer from this condition. This would lead one to expect that that operation which most satisfactorily and

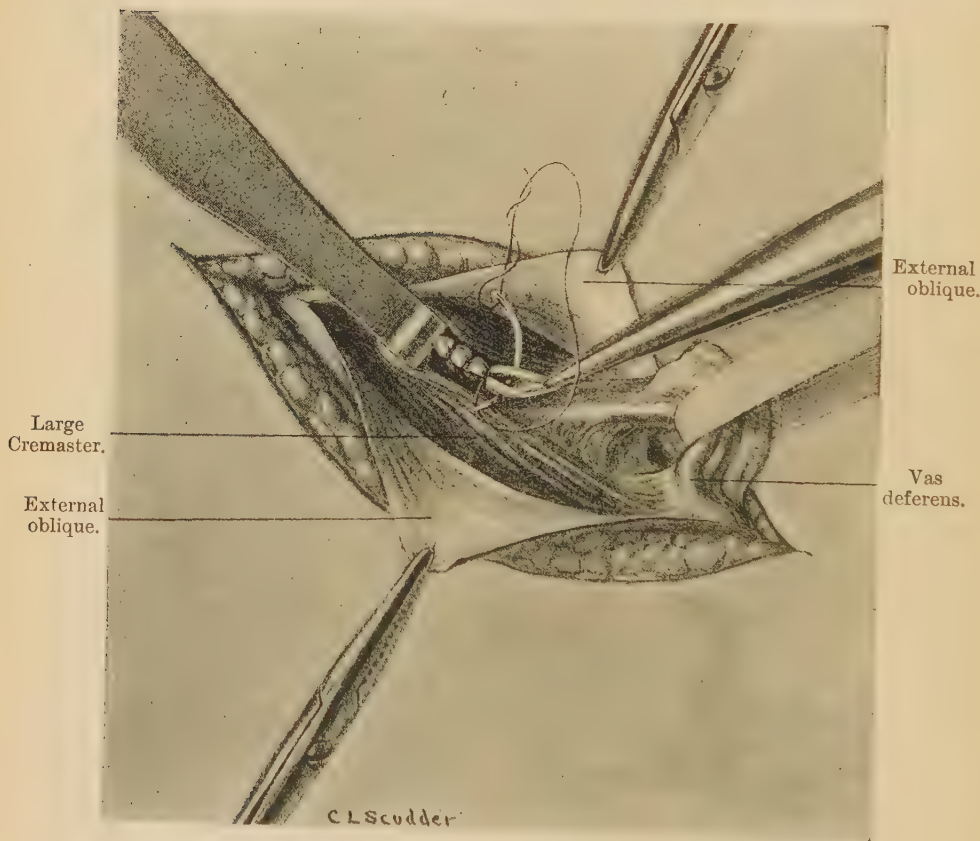
FIG. 13.



Bassini's operation. Showing the method of inserting the deep sutures. (Lockwood.)

simply reconstitutes the original condition of the inguinal canal will be attended with the most satisfactory results. Bassini's operation practically does reconstitute the normal inguinal canal, and moreover justifies the above argument, since the results are so satisfactory and its adoption is so widespread. Other advantages of Bassini's method are, that it is easy and straightforward to perform, and that the whole length of the canal is exposed to view, thus allowing (as pointed out by

FIG. 14.



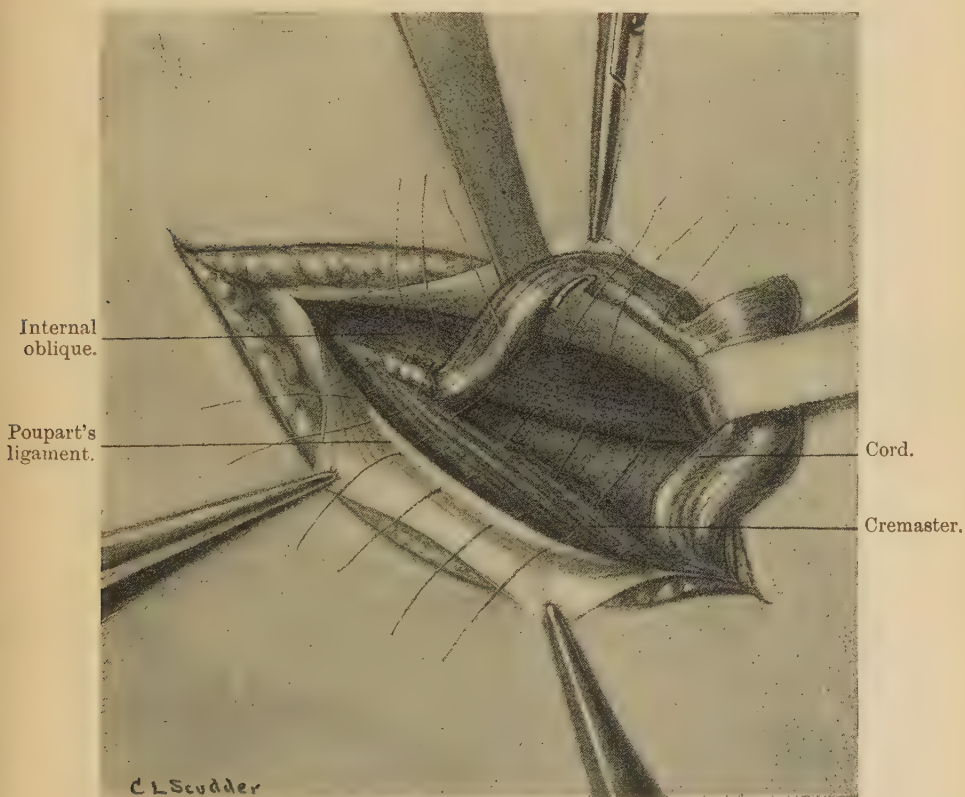
Scudder's modification of Bassini's operation. Sewing the neck of the sac, a retractor being used to expose it well. (*Ann. of Surg.*)

Lockwood) the removal of any conditions which may be liable to distend the inguinal canal, such as lipomata of the cord or inguinal varicoceles. For these reasons Bassini's operation will be described first.

(1.) *Bassini's Method* (Fig. 13).—An oblique incision, at least four inches long in an adult, somewhat less in a child, is made over the position of the inguinal canal, and ending below opposite the pubic crest. The fascia having been divided, the external oblique aponeurosis is exposed and the external abdominal ring identified. The external

oblique is now divided along the length of the canal, and flaps separated in both directions for a short distance, thus thoroughly exposing the whole length of the inguinal canal. In small herniæ it is not necessary to carry the incision in the external oblique into the external ring, and as this is difficult to reform accurately, the ring is best saved in these cases. The cremasteric fascia and the thin infundibuliform fascia are then divided. The sac is now identified and carefully separated from the cord well up to and an inch above the level

FIG. 15.

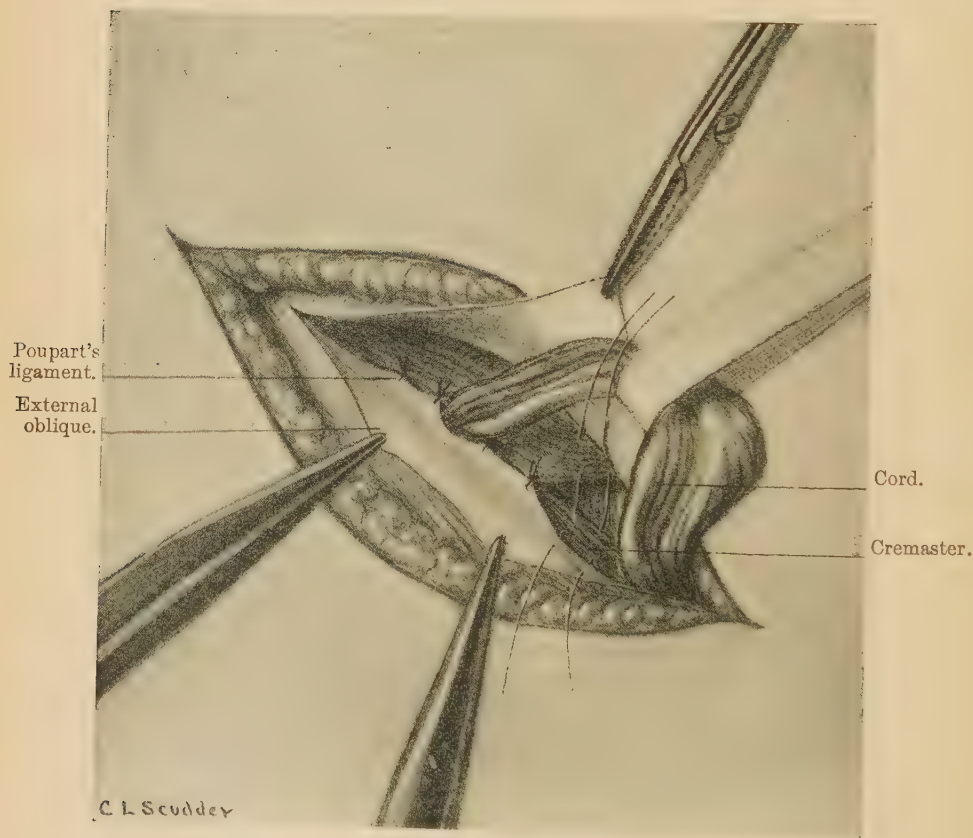


Scudder's modification of Bassini's operation. Note method of passing sutures, especially those above and external to the cord. (*Ann. of Surg.*)

of the internal ring. It is then opened and carefully emptied, all adhesions being carefully separated, and omentum either ligatured and removed or reduced. The neck of the sac having been somewhat pulled down, is transfixed and ligatured with silk or kangaroo-tendon at the highest possible point, then divided about half an inch below the ligature, and the rest of the sac removed. Next, the cord is raised carefully from its bed, and, supported in a loop of gauze, is held forward by an assistant while the sutures are introduced. At this stage any lipomata of the cord or an inguinal varicocele may be removed, as

advised by Lockwood. The posterior wall of the inguinal canal is now repaired by means of sutures. These will vary in number from four to six, according to the size of the gap between the internal oblique or conjoined tendon on the one hand, and Poupart's ligament on the other (*vide* Fig. 13). These sutures consist either of kangaroo-tendon, chromicised catgut, or silk, and are passed in the following manner:—The needle is first passed through the deep aspect of Poupart's liga-

FIG. 16.



Scudder's modification of Bassini's operation. Sutures above and below the cord tied except two. (*Ann. of Surg.*)

ment, then beneath the uplifted cord, and finally through the lower margin of the internal oblique or conjoined tendon. In order to avoid wounding the peritonæum, the needle is passed through the conjoined tendon from its deep to its superficial aspect (*vide* Fig. 13). Sufficient sutures having been passed, they are tied carefully and cut short, and the cord allowed to fall back into its place. The divided edges of the external oblique are now united by means of a fine continuous suture, and the external ring, if large, partially closed at the same time. All

bleeding having been carefully arrested, the skin is sutured and the dressings applied.

Scudder (*Ann. of Surg.*, vol. 41, 1905, p. 76), modifies Bassini's operation in several respects:—

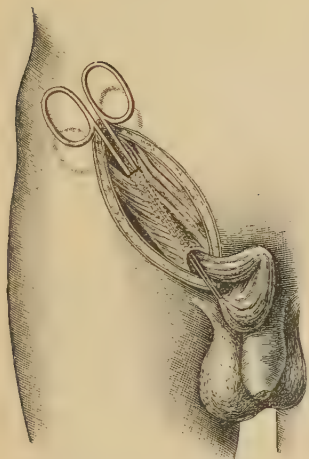
(a) He sutures the peritonæum *above* the neck of the sac, instead of ligaturing it (*vide* Fig. 14).

(b) He also places a couple of sutures to strengthen the attachment of the internal oblique to Poupart's ligament above and outside the cord. Bull and Coley also use this improvement to prevent recurrence at this likely spot (*vide* Fig. 16).

(c) Scudder's method of passing his sutures is also an improvement on Bassini's operation (*vide* Fig. 15).

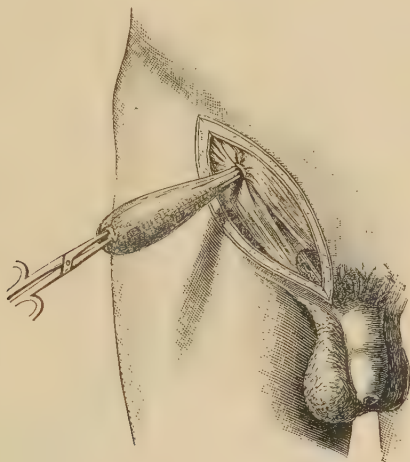
(d) He also overlaps the fibres of the external oblique. I practise

FIG. 17.



Kocher's operation by lateral transposition of the sac. The forceps, introduced along the inguinal canal, are grasping the sac at the lower end.

FIG. 18.



Kocher's operation by lateral transposition of the sac. The sac is drawn out through a small opening in the internal oblique muscle and the external oblique aponeurosis; it is then cut off and its stump is fixed by suture.

and recommend these improvements except the first, which I only employ for sacs with wide necks.

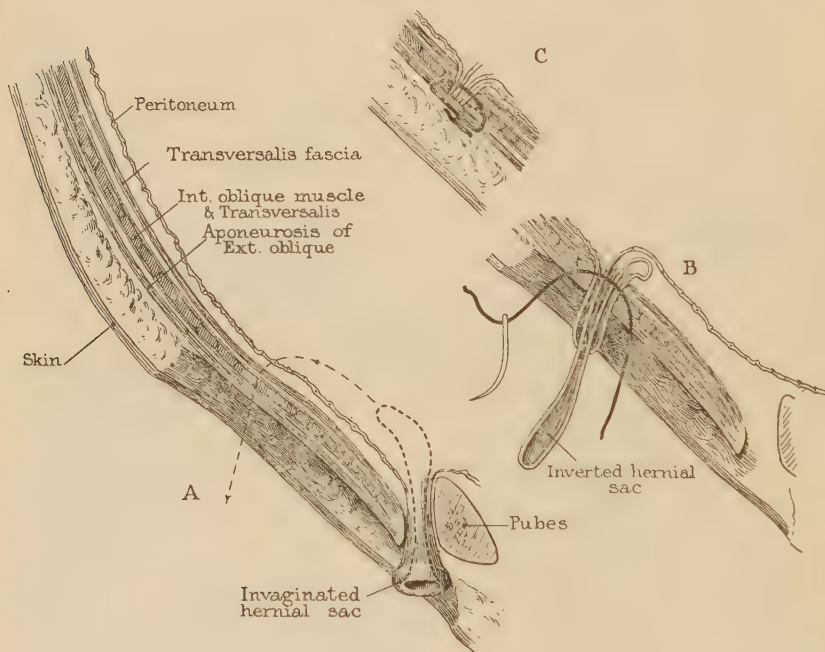
Kocher's Operations (Kocher, *Operative Surgery*, 1903. Translation by Stiles).—Professor Kocher has wisely abandoned his earlier method of treating the sac by torsion, and drawing it out through the external oblique aponeurosis and fixing it as a buttress along the anterior wall of the inguinal canal; the sac often sloughed after being treated in this way.

Kocher now uses two simpler and less dangerous methods of dealing with the neck of the sac.

(a) *The lateral transposition method.*—The external oblique aponeurosis, the external ring, and the sac are exposed in the usual way, *but the external oblique is not incised*. The sac is completely isolated and emptied. "A small opening is made in the strong portion of the

external oblique above and external to the middle of Poupart's ligament (above and external to the region of the internal abdominal ring), and a special pair of curved dressing-forceps is pushed through it, *i.e.*, through the aponeurosis of the external oblique and the muscular fibres of the internal oblique, and along the canal in front of the spermatic cord to emerge at the external ring, where they are made to seize the fundus of the isolated hernial sac, which is drawn from below upwards and outwards along the canal and through the small opening above mentioned. Traction is now made on the sac, so that, instead of running downwards and inwards along the cord, it is pulled in an out-

FIG. 19.



Sections to illustrate Kocher's second method of treating the sac by invagination.

ward direction from the internal abdominal ring, and the funnel-shaped opening at the neck of the sac is drawn well into the small opening in the abdominal wall. The portion of the sac which is brought through the opening is now transfixed and stitched to the adjacent part of the abdominal wall by a silk suture. The sac is cut off. It is still better to compress the sac with a narrow pair of pressure-forceps and then to ligature it. A very small stump is thus obtained, which can be cut off fairly close to the ligature. The narrow stump is pushed back through the fascia, and a needle is passed through the two sides of the opening in the fascia and through the stump, by which means the stump is stitched to the small opening in the fascia, and the latter is closed simultaneously. The peritonæum is thus stretched in a lateral direction, and the descent of a sac in the direction of the cord is rendered impossible" (*vide* Figs. 17 and 18).

(2.) *Transposition by invagination.*—The sac is exposed and isolated at the external ring as above, and freed as high up in the canal as possible. “The unopened sac is now seized at its apex with long, narrow, curved forceps and invaginated backwards through the inguinal canal up into the abdominal cavity. The point of the forceps is then forced against the abdominal wall, which is made to project just external to the internal abdominal ring.” A small incision is then made through the abdominal muscles overlying the point of the forceps. The parietal peritonæum and the hernial sac are then pushed outwards through the incision. The parietal peritonæum is incised, and the edges prevented from retracting into the abdomen. “The whole length of the invaginated sac is forcibly pulled out; the empty forceps in the inguinal canal are withdrawn at the same time. . . .” “The base of the sac is crushed with a pair of pressure forceps transfixed with a silk suture, and the two halves together with the parietal peritonæum are tied. The sac is cut off close to the ligatures, the stump pushed back under the fascia and the same silk suture is used to close the opening in the aponeurosis of the external oblique (*vide*, Fig. 19).”

Kocher completes each of the above operations thus:—A row of deep sutures, including the aponeurosis of the external oblique muscle and the muscular fibres of the internal oblique, is then inserted in order to strengthen and narrow the inguinal canal in its whole length.

Prof. Kocher claims that “this extremely simple method, besides causing very little injury to the tissues, is more effective in entirely reducing the hernial protrusion than any other, because the peritonæum from the neighbourhood of the internal abdominal ring is drawn out and firmly fixed in the opposite direction to the course of the spermatic cord, *i.e.*, it is maintained stretched in an outward direction.

“At autopsies performed at longer or shorter intervals after the operation, we have had the opportunity of seeing the results of this procedure. On the peritonæal aspect at the spot where the sac was drawn through a fine circular peritonæal cicatrix is seen as a prominence with two shallow recesses above and below it. The parietal peritonæum on the mesial aspect is raised in slight folds about 2 to 3 mm. in height. There is no sign of any invagination into the inguinal canal.”

However perfectly the funnel at the neck of the sac may be obliterated by Kocher's method, we do not like his way of narrowing the inguinal canal, for the cord is not dislocated outwards, so as to lengthen the inguinal canal and make it more oblique and valvular. The deep sutures are passed somewhat in the dark as regards the cord, and we prefer to open the canal to obtain a good view of the parts to be sewn together. In women and girls it has been shown that transposition of the comparatively small round ligament is not essential, therefore Kocher's method may be found useful in them; and in some cases of strangulated hernia, where time may be precious, this rapid way of performing a radical cure may be employed with advantage.

We prefer to use catgut or kangaroo-tendon for all the deep sutures for the reasons above given. When silk is used, the ligature which is employed to tie and fix the neck of the sac is apt to cause an early or late stitch sinus, because it has too much tissue within its grasp.

Kocher's treatment of the sac is not so simple as simple suture or high ligation, which can be practised when the canal is opened. Tho

thin sacs of children and some adults cannot be treated by invagination without considerable risk of laceration of the neck.

Very thick inelastic sacs and those with adherent contents are also unsuitable for this operation.

Lebensohn found 4 relapses in 111 of Kocher's earlier cases in which the method of lateral transposition had been used; "Hirschkopf found not a single relapse in 42 cases." No mention is made of the time of

observation of these cases, so that it is difficult to estimate the value of the figures.

(3.) *Macewen's Operation** (Figs. 20 to 26).

The object of this is two-fold: (1) So thoroughly to separate the sac as to allow of its being completely reduced into the abdominal cavity, there to rest on the inner surface of the ring, and acting as a bulwark-like pad to "shed the intestinal waves away" from it. Prof. Macewen thinks that if the sac be merely tied, however carefully and high up this is done, there remains a funnel-shaped puckering, the apex of which presents in the internal ring, and that this pouch gradually becomes a wedge, tending to open up the canal.

Thorough separation of the sac, and carrying this well within the peritoneal cavity, is absolutely needful, for if the sac be left in the canal it will act as a plug, keeping it open.

(2) Again, to close the dilated

Macewen's operation. The index finger, inserted along the inguinal canal, is separating the peritonæum from the internal aspect of the internal ring. The folded sac is behind. In this and the following figures a flap of skin and cellular tissue has been reflected, and the external oblique opened up so as to expose the canal and internal ring.

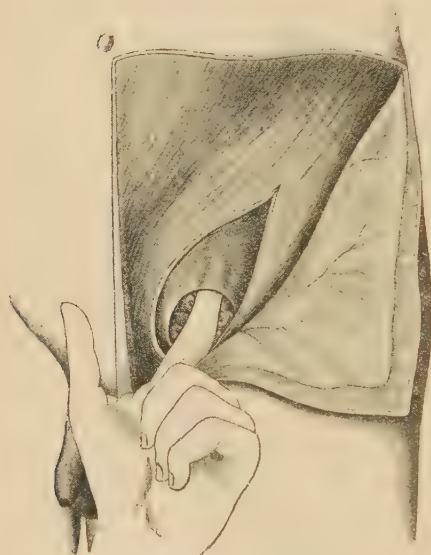
canal and restore its natural valve-like condition by a particular mode of inserting sutures which bring the conjoined tendon in close apposition with Poupart's ligament, beginning with that part of the ligament which is on a level with the lowest part of the internal ring.

The first object is thus ensured:—The external ring having been exposed, the internal ring and site of the deep epigastric are examined, and the sac next freed and raised. When this has been done it is kept pulled down while the index-finger separates the sac from the cord, the canal, and finally for half an inch around the abdominal aspect of the internal ring† (Fig. 20). The sac is now folded on itself (Figs. 21, 22)

* *Ann. of Surg.*, Aug. 1886; *Brit. Med. Journ.*, Dec. 10, 1887.

† The object of this is to refresh the abdominal aspect of the internal ring so that adhesions may form between it and the pad of sac.

FIG. 20.



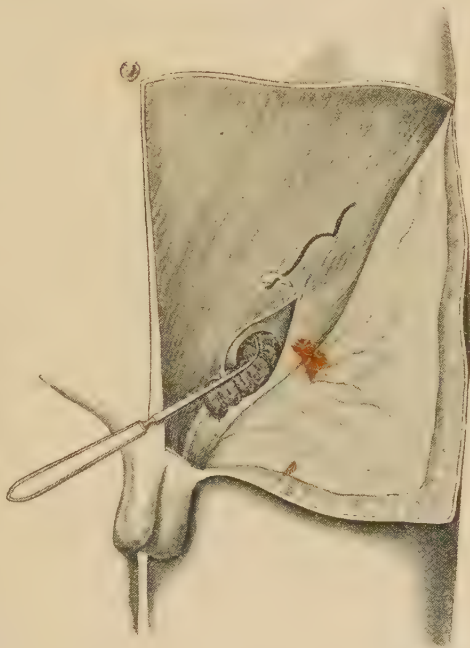
by means of a stitch which is firmly fixed in the distal end of the sac. The free end, threaded on a hernia-needle (Fig. 21), is introduced through the canal to the abdominal aspect of the fascia transversalis, and there penetrates the abdominal wall about an inch above the internal ring (Fig. 22). The wound in the skin is pulled upwards,* so as to allow the point of the needle to project through the muscles without penetrating the skin. The needle being withdrawn and unthreaded, by traction on the thread the folded sac is drawn still further backwards and upwards. Traction having been kept up on the thread while the sutures closing the canal are introduced, it is finally secured by passing it several times through the external oblique muscle.

The second part of the operation, closure of the inguinal canal, is now undertaken. The finger, passed into the canal and lying between the inner and lower border of the internal ring in front of and above the cord, makes out the position of the deep epigastric artery so as to avoid it.

The hernia-needle, carrying chromic gut, then, guided by the index, is made to penetrate the conjoined tendon in two places: first, from without inwards near the lower border of the conjoined tendon; and secondly, from within outwards, as high up as possible in the inner aspect of the canal: this double penetration of the conjoined tendon being accomplished by a single screw-like turn of the instrument (Fig. 23). One end of the suture is then withdrawn, and the needle, with the other end, is removed. Thus, a loop is left on the abdominal aspect of the conjoined tendon, which is penetrated twice (Fig. 24).

Secondly, the other hernia-needle, threaded with that part of the

FIG. 21.



Macewen's operation. The hernia-needle is carrying the suture, threaded through the sac, through the abdominal muscles, from behind forward, about an inch above the internal ring.

* Beginners will find it best to divide the aponeurosis of the external oblique, and so obtain sufficient room for rightly dealing with the sac. This requires an additional row of sutures, and may weaken the abdominal wall. On the other hand, beginners will always find it difficult, however much the upper angle of the wound is pulled up, to get the sac detached really high up, and to put the needful sutures into the conjoined tendon with the limited incision which is sufficient for the experienced hands of Prof. Macewen.

suture which comes from the lower part of the conjoined tendon, guided by the index in the inguinal canal, is passed from within outwards through Poupart's ligament, which it penetrates at a point on a level with the lower suture in the conjoined tendon (Fig. 25). The needle is then completely freed from the suture and withdrawn.

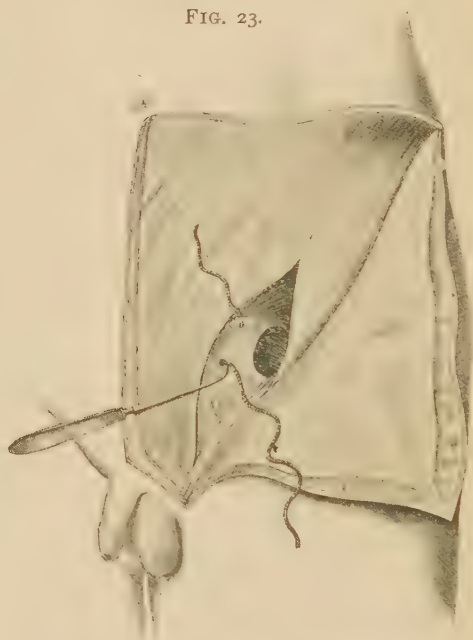
Thirdly, the needle, now threaded with that part of the catgut which protrudes from the upper border of the conjoined tendon, is passed from within outwards through the transversalis and internal oblique muscles and the aponeurosis of the external oblique at a point on a level with the upper stitch in the conjoined tendon. It is then quite freed from

FIG. 22.



On the left is one of Prof. Macewen's needles.* They are made of one piece of steel. To the right is the sac, trans-fixed and thrown into a series of folds by a thread which should be shown emerging above as well as below.

FIG. 23.



Macewen's operation. A hernia-needle (loaded) has been made to penetrate the conjoined tendon in two places.

the suture and withdrawn. There are now two free ends in the outer surface on the external oblique, continuous with the loop on the abdominal surface of the conjoined tendon (Fig. 26). The two free ends being drawn together tightly, and tied as a reef-knot, the internal ring is firmly closed. The same stitch may be repeated lower down in the canal, especially in adults, with wide gaps. The pillars of the external ring may likewise be brought together. In the great majority of cases the first or uppermost stitch is all that is required. The cord should lie behind and below the sutures and be freely movable in the

* These are two in number, one for passing the thread from right to left, and the other from left to right. I have found Mr. Watson Cheyne's modification of the above needles, in which the instrument is angular instead of curved, much more convenient for picking up the conjoined tendon and external oblique.

canal. It is advisable to introduce all the sutures before tightening any of them. They may then be experimentally drawn tight while a finger is introduced into the canal to learn the result. During the operation the skin is drawn from side to side to bring the parts into view. The skin falling into position, the wound is opposite to the external ring, the operation being partly subcutaneous.

In congenital hernia the sac is first separated from its connection with the canal. It is then opened, and divided transversely into two parts, care being taken to preserve the cord. The lower part forms a tunica vaginalis. The upper is pulled down as far as possible, split behind longitudinally, so as to allow the cord to escape, and its lower end closed by a stitch or two. It is then dealt with quite as the sac of an acquired hernia.

The following points deserve attention.

The method has been objected to as complicated and difficult, and as inapplicable to infants on account of the difficulty of making out any conjoined tendon at this age. The above objections will disappear with practice. As Prof. Macewen has stated, a skilled finger will detect the conjoined tendon even in early life. Smaller needles must, of course, now be used. Other difficulties are met with in this method when the sac is unusually coarse and thick, or when it is extremely thin; such sacs are, no doubt, difficult to manipulate satisfactorily, so as to get the pad well within the internal ring.

Professor Macewen kindly forwarded to me the following statement (July 1895) as to his results:

"I have had 164 completed cases of operation for oblique inguinal hernia. Regarding radical cures, one must necessarily be guarded in drawing conclusions when dealing with large numbers, as many of the patients pass from observation, and, though asked to report themselves, do so only a few times, and then cease. Thus out of 164 there are 55 who have dropped entirely out of view. Many of these had previously been seen three to nine months after operation, when they had firm occlusion of the abdominal wall. Two children died after the operation—one from scarlet fever, epidemic at the time, and one from measles and meningitis, the latter rather a weak child. This leaves 107; of these, five are known to have had return. Two of these were steel workers, doing the heaviest kind of work. One was cured during eight

FIG. 24.



Macewen's operation. A loop has been left on the inner surface of the conjoined tendon.

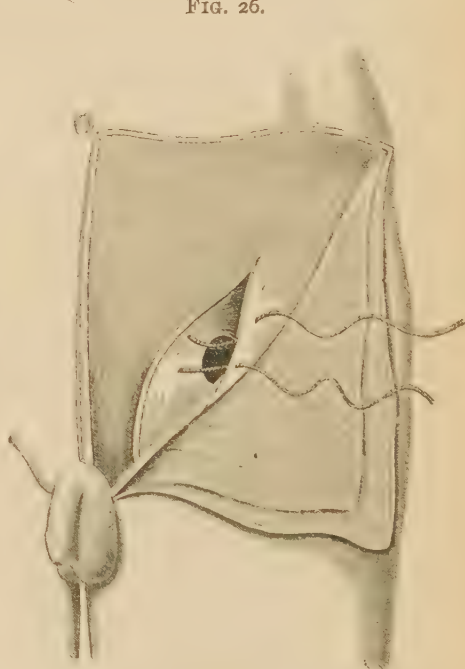
years, and then a slight bulge appeared near the seat of the former hernia. He now has a bubonocoele. The other was two years free from hernia, and then had a slight rupture. Each of those wear belts—light ones, which retain the hernia even during their work. A third remained well for two years, then had an attack of what was stated to be enteric fever, and subsequently became affected with tubercle of the lungs. He had a distinct recurrence of the hernia. A fourth I have

FIG. 25.



Macewen's operation. The thread from the lower part of the conjoint tendon has been carried through Poupart's ligament.

FIG. 26.



Macewen's operation. Two of the threads which are to draw the conjoint tendon over to Poupart's ligament are in position ready for tying.

heard of as having a return to a slight extent, and a fifth wrote to say that he had a return.

“If we strike off nine cures under two years, which are well, but which are too recent to be judged as cures, this leaves—

20 reported or seen cured—no truss—at 10 years and over.

11	”	”	”	”	8	”	”
18	”	”	”	”	6	”	”
29	”	”	”	”	4	”	”
15	”	”	”	”	2	”	”
—							

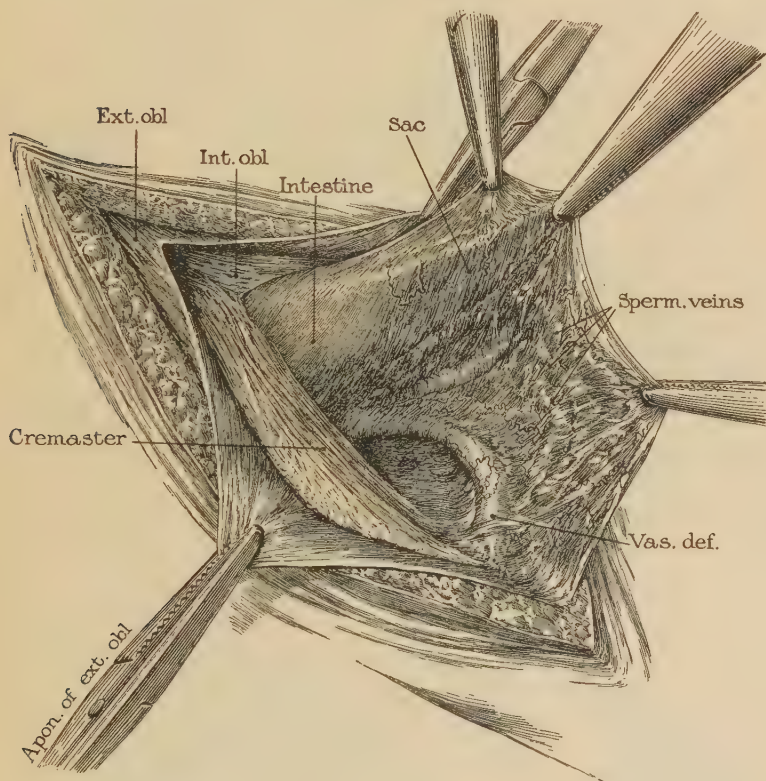
93

Some of the older ones have been good enough to keep me well informed as to their state. Two have gone through a great deal of hard riding in Cape, for many months at a time, and have never been

bothered with their old enemy. One, a surgeon in the Cumberland district, rides a great deal and never is troubled. He says he has forgotten that he ever had a hernia."

Although in Prof. Macewen's hands this method has been attended with good results, when performed by other surgeons the results have not been so satisfactory. It is clearly a more difficult and complicated procedure than Bassini's, and moreover the results of Bassini's method

FIG. 27.



Halstead's operation. Before the veins and fat have been excised.

are better (*vide supra*, p. 64). Probably it is for these reasons that Bassini's method is preferred by the majority of operators.

It does not lengthen the inguinal canal, and render it more oblique and valvular, points which we regard as of the first importance in the radical cure of inguinal hernia.

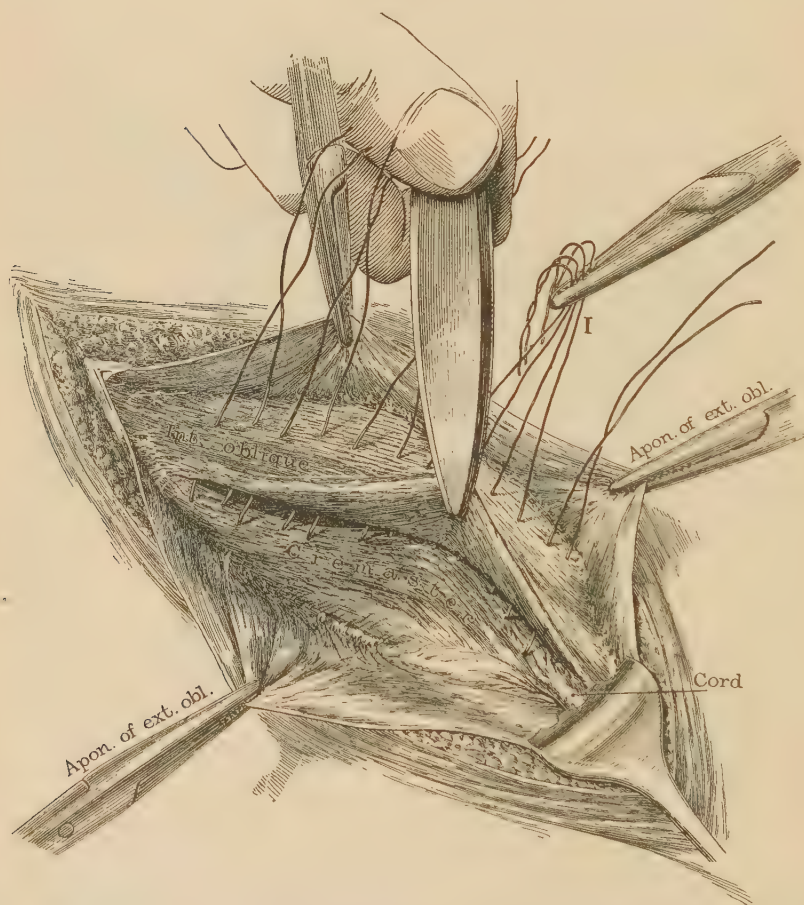
(4.) *Halstead's Operation* (*Johns Hopkins Bulletin*, August, 1903).

Halstead's original operation has been very much modified by Halstead and Bloodgood. The inguinal canal is opened as in Bassini's operation and the cremasteric fascia and muscle are then incised along the superior border of the spermatic cord. The internal oblique muscle and the conjoined tendon of this and the transversalis muscle are thoroughly exposed and defined. The spermatic veins, if enlarged as

usual, are excised, care being taken to avoid any extravasation of blood into the loose areolar tissues around the vas deferens, and the small veins which accompany it. The vas is not touched or moved lest thrombosis of its veins occur.

The spermatic veins are pulled down, transfixed and tied as high up as possible; another ligature is similarly applied to these veins just

FIG. 28.

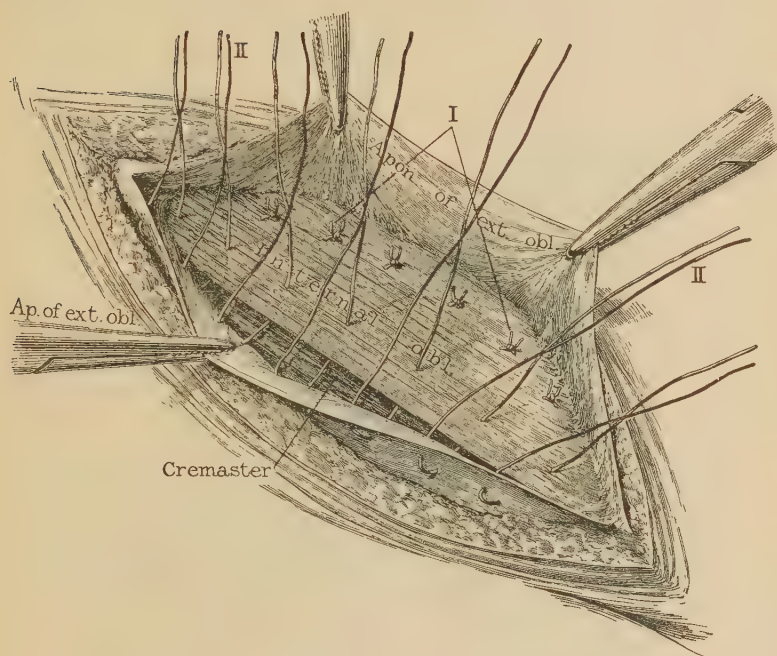


Halstead's operation. Sewing the cremaster deep to the internal oblique.

below the external ring, and the intervening bundle is excised leaving no large veins in the canal, which can therefore be almost completely obliterated by the following steps.

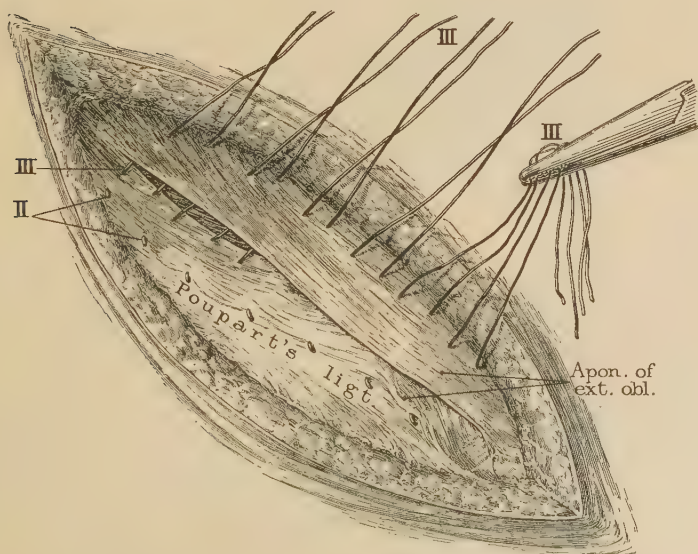
The neck of the sac is transfixed and tied as high up as possible, and the ends of the ligature are threaded on long curved needles which are passed deep to the arching fibres of the internal oblique and transversalis, to pierce these muscles at two points one-eighth of an inch apart well above and outside the internal abdominal ring. The ligatures are tied; they serve to displace the neck of the sac outwards,

FIG. 29.



Halstead's operation. Sewing the deep muscles to Poupart's ligament.

FIG. 30.

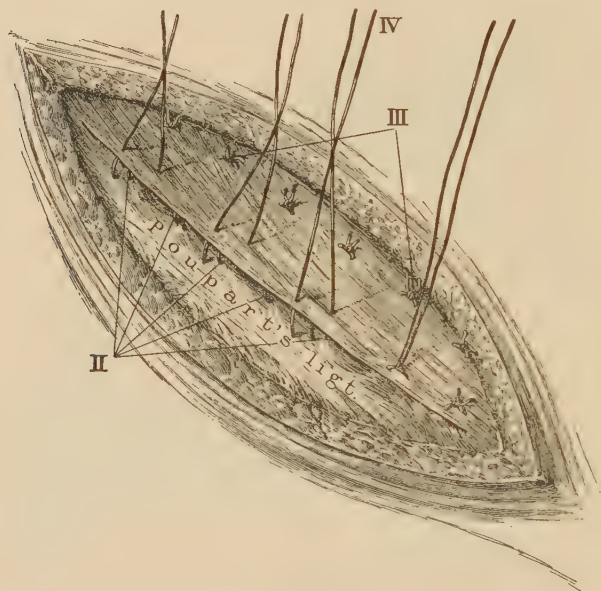


Halstead's operation. Overlapping the external oblique.

and any funnel that may remain above the ligature (*vide* Kocher's lateral transposition method).

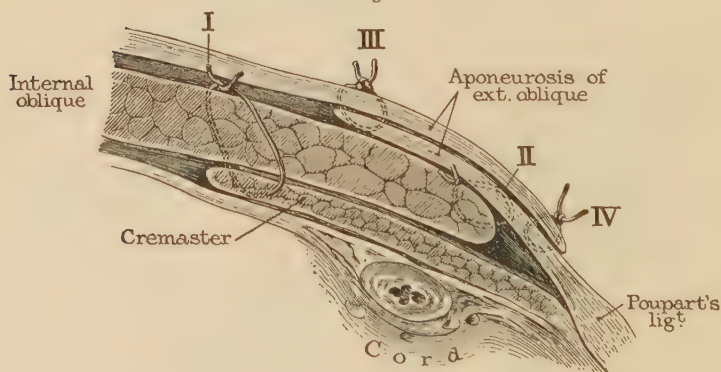
The lower flap of cremasteric fascia and muscle is now drawn up deep

FIG. 31.



Halstead's operation. Sewing down the edge of the external oblique.

FIG. 32.



Halstead's operation. Section to show the overlapping.

to the internal oblique and the conjoined tendon, and fixed there by fine interrupted sutures (*vide* Fig. 28 I.).

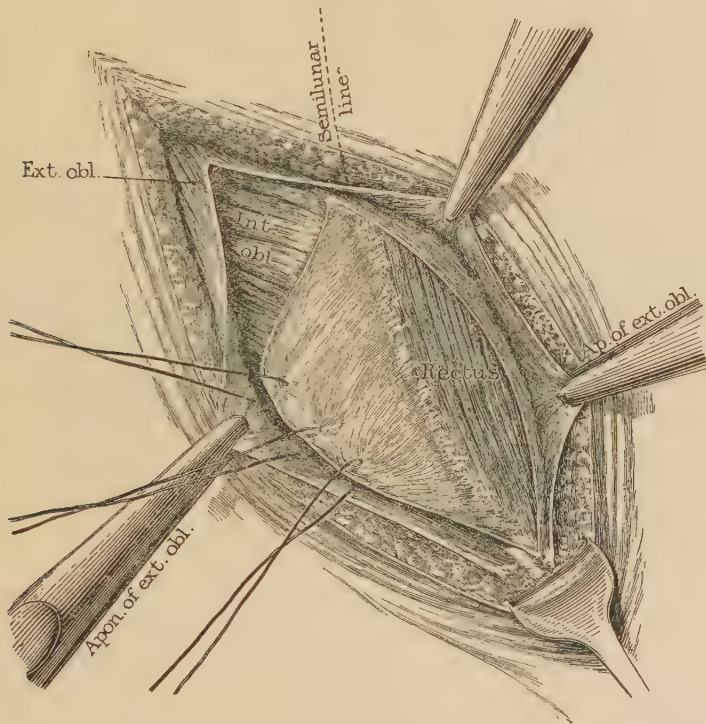
The internal oblique muscle and the conjoined tendon are then joined to the deep surface of Poupart's ligament by means of stouter interrupted sutures (*vide* Fig. 29 II.).

If necessary the rectus sheath may be incised vertically in order to allow the lower sutures to be tied without undue tension.

This is found very useful when the conjoined tendon is narrow and atrophied. The wound in the external oblique aponeurosis is closed by the Andrews-Halstead overlapping method (*vide* Figs. 30 to 32).

If the hernial orifice is very large, a flap of the anterior wall of the rectus sheath may be reflected downwards and outwards and sewn to the deep surface of Poupart's ligament (*vide* Fig. 33); or the outer margin of the rectus sheath may be slit up to liberate the rectus muscle, which may then be sutured to Poupart's ligament (Bloodgood,

FIG. 33.



Halstead and Bloodgood's operation. Turning down a flap of rectus sheath to strengthen the lower and inner part of the canal.

Johns Hopkins Reports, vol. vii., and Wöfler, "Beiträge z. Fest. f. Th. Billroth").

The results of this very extensive and elaborate operation are very good as regards the cure of the rupture, and Halstead states that not a single recurrence has been charged to him from 1892 to 1903. The difficulties of following up cases, especially unsuccessful ones, must not be forgotten, however.

When it was customary to dislocate the vas deferens, atrophy of testis used to follow the operation in 10 per cent. of the cases, but since 1899 not a single case of this serious complication has been observed at the Johns Hopkins Hospital, although epididymitis and vaginal hydrocele are not uncommon.

Halstead's operation in its modern and modified form is no doubt

suitable for many cases of large inguinal hernia with large canals and fatty bulky cords. The removal of nearly the whole cord greatly facilitates the radical cure, for "the cord is the first cause of the hernia and the ultimate obstacle to its cure" (Halstead).

(5.) *Nicoll's Operation* (*Ann. of Surg.*, January, 1906).

Nicoll only recommends this extension of his operation for femoral hernia to some cases of very large inguinal hernia, especially to those with wide necks, which occur in elderly men. In them Poupart's ligament is too weak and mobile to be used as a fixation point for the internal oblique and conjoined tendon; Prof. Nicoll therefore sutures these structures to the horizontal ramus of the pubis.

The sac having been treated as in Nicoll's operation for femoral hernia (*vide* p. 99), the periosteum of the horizontal ramus is incised from the femoral sheath to the pubic spine. This incision is just below and parallel to the ilio-pectineal line. The bone is drilled horizontally at two points about three-quarters of an inch apart. The drill may be passed through the pubic fascia lata just below Poupart's ligament; this enables the operator to pass the drill more horizontally than is possible from above Poupart's ligament. Two stout mattress sutures of catgut or kangaroo-tendon are then employed to bring the internal oblique and conjoined tendon down to the bone. Each suture takes a broad grip of these structures, and each is withdrawn through both of the holes in the bone and tied either deeply or superficially to the pubic fascia lata.

A special silver probe, with an eye close to its end, greatly facilitates the withdrawal of the sutures from above downwards through the bone (*vide* Fig. 41).

The sutures may be passed either behind or in front of the spermatic cord. We should always prefer to pass them behind the cord, thus rendering the new inguinal canal more oblique and valvular.

Poupart's ligament is now sewn to the anterior surface of the conjoined tendon and internal oblique in front of the cord.

We regard this operation as worthy of trial in suitable cases. Prof. Nicoll publishes a modification of the operation, which consists in suturing the conjoined tendon and internal oblique to the anterior lip of the periosteal wound on the horizontal ramus of the pubis: this may be used if suitable instruments be not available for the more radical operation.

RADICAL CURE OF FEMORAL HERNIA.

There is less necessity for operative interference here—women, in whom the above variety is so much more frequent, finding a truss more efficient and less irksome, owing to their less active life and their mode of dress. On the other side it must not be forgotten that strangulation is proportionately more frequent, more often overlooked, and more fatal in femoral than in inguinal hernia. In omental hernia, where there is difficulty in fitting or unwillingness to wear a truss, in irreducible hernia, and in all cases of strangulated hernia, where the patient's condition and the surroundings of the operator admit of it, an attempt should be made to cure the hernia permanently. We are met here by a difficulty less present in inguinal hernia—*i.e.*, that of

closing the canal satisfactorily, owing to the rigidity of some of its immediate surroundings and the importance of others.

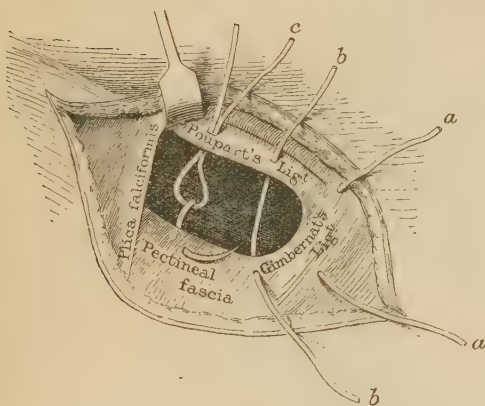
Finding the sac.—Care must be taken not to mistake the distended fascia propria or the anterior wall of the femoral sheath for the sac, and the subperitonæal fat for adherent omentum (*vide* p. 44).

(A.) **Different methods of treating the sac.**

i. The empty sac having been thoroughly separated from its surroundings—a step here usually carried out with ease—is twisted up tightly, transfixed, and tied as high as possible, and then thoroughly invaginated within the femoral ring.

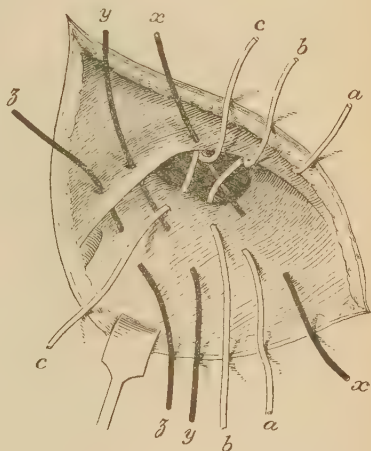
ii. Kocher's method (p. 81) may be employed. The empty sac having been isolated is invaginated into the abdominal cavity by means of a pair of long curved forceps, and then brought out through a small

FIG. 34.



Bassini's operation for femoral hernia (modified from Binnie's Operative Surgery). Passing the first set of sutures.

FIG. 35.



Bassini's operation for femoral hernia (modified from Binnie's Operative Surgery). The second set of sutures ready for tying.

opening made in the whole thickness of the abdominal wall above Poupart's ligament, and its stump fixed there by suture.

iii. The sac may be treated much as in the methods of Barker and Bennett. Thus, after it has been isolated and emptied, the neck is thoroughly cleared with the finger passed up the femoral canal. The neck is now ligatured as high up as possible, the body of the sac cut away, and the ends of the ligature, which have been left long around the neck of the sac, are carried up the femoral canal by means of needles on handles along the index finger, and made to emerge in front of the peritonæum through the external oblique aponeurosis just above Poupart's ligament, about half an inch apart. When these are tied the neck of the sac and any funnel that may remain above the ligature will be drawn away from the region of the femoral ring. While the above ligatures are being passed one assistant should protect the femoral vein, while another draws up the upper angle of the skin incision so that the needles may emerge in the wound.

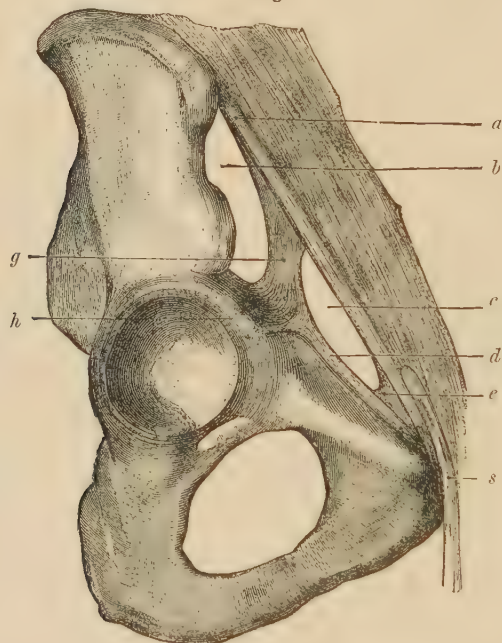
iv. The sac having been isolated below Poupart's ligament, may be drawn upwards through the femoral canal into a wound made by slitting the fibres of the external oblique muscle; its neck can then be tied higher up than by mere separation and traction from below (*vide* Lotheissen's Operation).

v. MacEwen's method of dislocation of the sac, and fixing it as a pad above the femoral ring (*vide* p. 82).

vi. Nicoll's modification of the above (*vide* p. 99).

(B.) Closure of the Femoral Canal.—The other cardinal step in

FIG. 36.



a, Poupart's ligament. *b*, Lacuna muscularis. *c*, Lacuna vascularis. *d*, Cooper's ligament. *e*, Gimbernat's ligament. *g*, Ilio-pectineal ligament. *h*, Ilio-pectineal eminence. *s*, Spermatic cord. (Lockwood.)

the radical cure of femoral hernia—closure of the femoral canal and ring—is much more difficult here, for reasons above given.

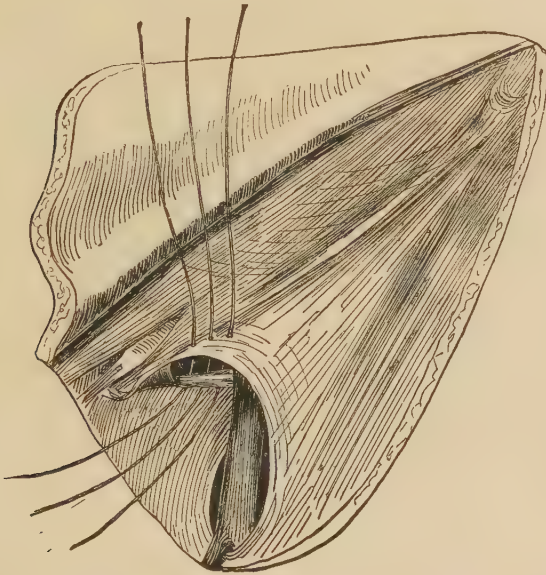
1. *Bassini's Method*.—After high ligation and removal of the sac, the canal is closed in the following manner:—Three sutures are passed through Poupart's ligament and the pectineal fascia (*vide* Figs. 34 and 35). These are left untied while three or four more sutures are inserted and tied. These unite the falciform ligament to the pectineal fascia, the lowest being placed close to the saphenous vein. Bassini has published fifty-four cases operated upon by this method, without any recurrence in forty-one cases, traced from one to nine years.

2. *Lockwood's Method** (Figs. 36, 37, and 38).—The stump of the sac is first drawn up and fixed as above described (iii., p. 93). The

* *Hernia, Hydrocele, and Varicocele*, p. 192.

subsequent steps are described by the author as follows: "For this purpose the index finger of the left hand is pushed up the femoral canal so that it lies with its dorsum against the common femoral vein, and its tip upon and a little within the ilio-pectineal ridge. The finger is intended to protect the vein from the point of the herniotomy-needle, and to guide the latter as its point is thrust beneath Cooper's ligament (*vide* Fig. 36). In cases in which the femoral canal has been distended and stretched, the needle can be guided by vision. The herniotomy-needle is passed in the following manner:—Having been armed with about one and a half feet of No. 4 or 5 twisted silk, its point is guided up the femoral canal until it rests against the inside of the linea ilio-pectinea, opposite the outer edge of Gimbernat's ligament. The needle

FIG. 37.



Lockwood's operation. Showing the mode of suturing the femoral canal.

is then rotated so that its point scrapes over the linea ilio-pectinea and picks up Cooper's ligament. Finally, the point emerges through the upper part of the pectineal fascia, where it is unthreaded and withdrawn, leaving the suture beneath Cooper's ligament (*vide* Fig. 37). Additional sutures are passed in exactly the same way, but each a little farther outwards until the last lies at the inner edge of the common femoral vein. Two or three sutures generally suffice, but I have used as many as five. The next step is to again thread the upper end of each ligature in turn through the herniotomy-needle, and, by pushing the point of the needle half-way up the femoral canal and rotating it forwards, pass the thread from within outwards through Hey's ligament close to its junction with Poupart's ligament (*vide* Fig. 37). Before knotting these threads they are pulled tight, to see whether enough have been passed to make a thorough and firm closure of the femoral canal, but without compressing the femoral

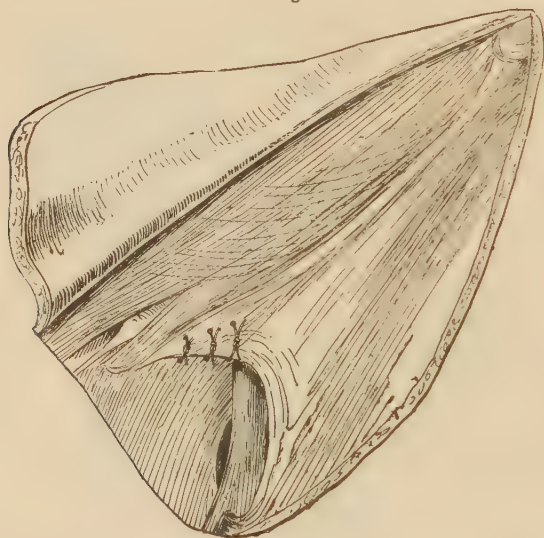
vein (*vide* Fig. 34)." The final results of Mr. Lockwood's cases are not fully given, owing to the difficulty in following them up. Ten cases, however, are mentioned. In nine of these the result was satisfactory after periods varying from one to seven years; the tenth case relapsed suddenly at the end of six months.

3. Kocher's method differs very little from the above; he sews Poupart's ligament down to the ligament of Cooper and the pectineal fascia and muscle.

Professor De Garmo (*Ann. of Surg.*, vol. 42; 1905), after ligaturing the sac high up and removing it, closes the femoral canal in a manner almost identical with that of Kocher.

Since 1890, De Garmo has used his method for 110 cases, with only one certain and one doubtful recurrence, and one death which occurred

FIG. 38.



Lockwood's operation. Showing the closure of the femoral canal completed.

in a late case of strangulated hernia from perforation of the bowel after its reduction by operation. Of the 110 herniæ, 28 were strangulated at the time of the operation, and the remaining operations were simple radical cures. In three of the patients the hernia had relapsed after operation elsewhere; all these recurrent cases have remained well for over four years.

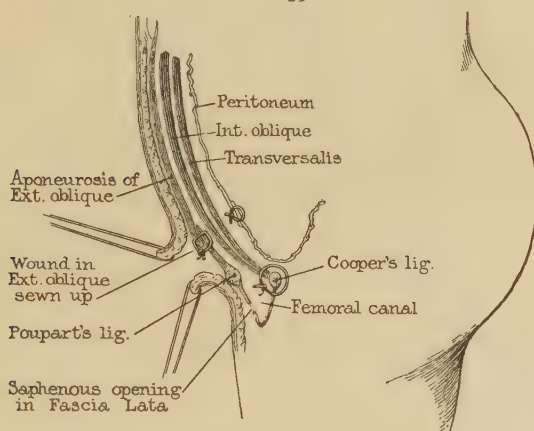
The above results are somewhat misleading, for it is not stated how many of the cases were traced and thoroughly examined. It is written that "by far the greater number have been traced and the permanence of the cure ascertained"; this is too vague to be of much value. Again, the time of observation is not mentioned, although it is probable that it extended over some years in the majority of the cases. It is pretty certain that recurrences after the radical cure of femoral hernia come late, the majority appearing after two years if the canal has been closed by sutures (Kammerer, *Ann. of Surg.*, p. 983, vol. 39, 1905).

Hutchinson carefully observed sixteen of his own cases treated as above (*Lancet*, vol. i. 1906, p. 964). The patients were traced for from two to ten years. Two relapses occurred, one after three years; the other came earlier in a case of strangulated hernia in a woman who had bronchitis after the operation.

4. *The Purse-string Method of Cushing and Curtis*, adopted by Coley (*Annals of Surgery*, vol. xxxvii., p. 801, 1903).

After high ligation of the sac and removal of all sub-peritoneal fat from the femoral canal Coley closes the femoral canal high up with a purse-string suture of kangaroo tendon. This stitch is introduced through Poupart's ligament near its inner end, then through the pectineus fascia and muscle, the fibrous septum of the femoral sheath internal to the femoral vein, and forwards through Poupart's ligament about a quarter of an inch from the point of entry. This suture can

FIG. 39.



Diagrammatic section to illustrate Lotheissen's operation for femoral hernia.

be passed more safely in the opposite direction, the femoral vein being more easily avoided.

This operation is very simple, and can be performed quickly; hence it is especially useful in critical cases of strangulated hernia.

Coley (*loc. supra cit.*) publishes 50 cases with no recurrence, also 16 operations by Bassini's method, with one relapse in a patient whose wound had suppurated.

Of these 66 cases, 46 were traced for from one to ten years, and 34 from two to ten years. The chief objections to this operation are that it is difficult to retain such rigid structures as surround the femoral canal by a purse-string suture, and that the femoral vein is especially liable to be wounded.

5. *Lotheissen's Operation* (*Centralblatt für Chirurgie*, 1898) (Fig. 39).

An incision is made half an inch above and parallel to the inner half of Poupart's ligament, separating the fibres of the external oblique aponeurosis.

The edges of this incision are retracted and the neck of the sac exposed and isolated just above the femoral ring and below the curved margin of the internal oblique and conjoined tendon. The empty sac

can generally be drawn upwards into the wound, but with large and irreducible herniæ this is not possible; in them the lower border of the cutaneous wound is freed and retracted sufficiently to expose the sac at the saphenous opening in the usual way. The sac is opened and emptied, and its ligated stump is drawn upwards through the femoral canal into the wound in the external oblique. The neck of the sac is then easily tied so high that no funnel can remain above the ligature.

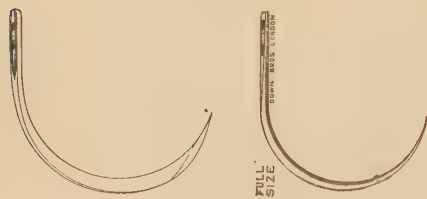
The essential part of the operation, however, is the closure of the *upper end* of the femoral canal by joining the lower margins of the internal oblique and transversalis to Cooper's ligament.

Sutures of kangaroo tendon or chromicised gut are passed by means of acutely curved round needles first (*vide* Fig. 40) through the mobile muscular arch and then under Cooper's ligament, which is fixed (*vide* Fig. 39). The first suture should be passed close to Gimbernat's ligament, and the last near the femoral vein, the point of the needle being guided by the finger (introduced through the saphenous

opening), which should also carefully protect the femoral vein. Three or four sutures are generally enough. Care must be taken not to wound or compress the vein with the last suture.

The wound in the external oblique is now closed by a continuous catgut suture. The writer overlaps the edges of this wound to give greater support. Two

FIG. 40.



Symonds' needles.

years later Gordon described an operation almost identical with the above (*Brit. Med. Journ.*, vol. i., 1900).

According to Gilli, this operation is frequently performed at Von Hacker's clinic, and with very good results (*Centralblatt für Chirurgie*, 1903). I complete the operation by closing the saphenous opening (*vide* Fig. 35).

It seems to me to be the operation which most closely approaches the anatomical ideal, for the canal is closed at its upper end, instead of lower down, as in all the older operations, and the sac can be tied at a higher plane. In practice it is not very difficult to perform, if only suitable needles be employed. A vertical skin incision is more generally useful than the horizontal one, and this is especially true of irreducible and strangulated herniæ, in which the sac has to be isolated and emptied from below Poupart's ligament.

This operation is not at all easy in very stout patients; the conjoined tendon and internal oblique muscle are then fatty and difficult to define in a deep wound.

6. *Battle's Operation* (*Lancet*, vol. i. p. 302, 1901).

Battle separates the fibres of the external oblique aponeurosis and treats the neck of the sac in the same way as Lotheissen. He then sutures the upper margin of the wound in the external oblique to the pectineal fascia, Gimbernat's and Poupart's ligaments. Care must be taken to avoid injuring the femoral vein in passing these stitches. The lower margin of the same wound is sewn to the anterior surface of the external oblique above the upper margin, which it overlaps, thus

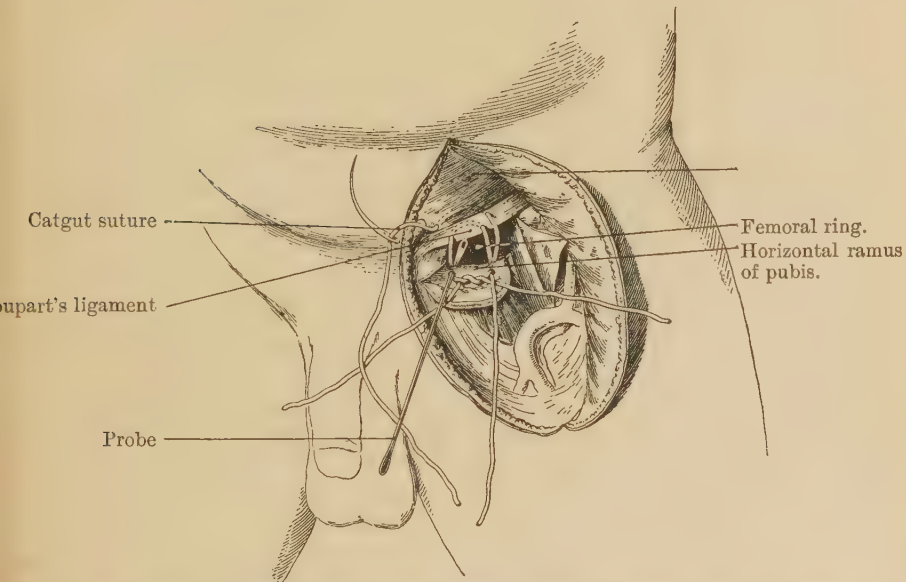
strengthening the anterior wall of the inguinal canal, and diminishing the tension on the first set of sutures.

The upper extremity of the femoral canal can be very thoroughly closed in this way, but it is somewhat difficult to bring the tendinous external oblique down to the pectineal fascia and to retain it there without undue tension. It is far easier to bring the more movable and elastic internal oblique to Cooper's ligament, and the strain on the stitches is much less.

7. *Nicoll's Operation* (*Annals of Surgery*, January, 1906) (Fig. 41).

Professor Nicoll first described his operation in 1902 (*Brit. Med.*

FIG. 41.



Nicoll's operation for femoral hernia. Stout catgut sutures are passed through the ramus of the pubis and Poupart's ligament. (Redrawn from Nicoll's paper, *Ann. of Surg.*)

Journ., November, 1902), and recommended it for difficult cases of femoral hernia; but he now employs it in nearly all his cases.

(A) Treatment of the Sac.

This is isolated, and the peritonæum is separated from the parietes for about one inch above and around the femoral ring. The sac is then bisected longitudinally, and one of the halves is pierced near its base, the other half being drawn through this aperture. The neck of the sac is thus closed without the aid of a ligature. The sac is then pushed up to the abdominal aspect of the femoral ring, where it raises the parietal peritonæum into a projection towards the abdominal cavity.

This procedure is alleged to save time, and to be easier and safer than other methods of transplantation of the sac, which may interfere with the nutrition of the sac and lead to sloughing of it. I do not think a buttress above the femoral ring is either necessary or advantageous; the treatment by simple and high ligation is far preferable.

(B) **Closure of the Femoral Ring.**—i. An incision is made from the femoral vein to Gimbernat's ligament through the pectineal fascia and periosteum just below the ileo-pectineal line, exposing the horizontal ramus of the pubis. Two drill holes are now made in the bone, one near Gimbernat's ligament, and the other near the femoral vein; they are about three-quarters of an inch apart. A loop of stout catgut is passed through one of the apertures from before backwards by means of a silver probe with an eye very near its extremity. The loop is divided and the probe withdrawn. The posterior ends of the sutures are passed as mattress sutures through Poupart's ligament at different levels by means of a curved surgical needle. The ends are then drawn forwards through the second aperture in the bone with the aid of the pliable probe.

The stitches are tied separately, bringing Poupart's ligament into contact with the postero-superior surface of the bone, and fixing it there firmly, and closing the femoral ring. In passing the sutures through Poupart's ligament, care must be taken to avoid wounding the deep epigastric artery and the cord; and in making the punctures in the bone, the outer one should be neither too near nor too far from the femoral vein, which must not be compressed when the ligatures are tied, yet the femoral ring must be well closed.

ii. The pectineus muscle and its fascia, which form the lower lip of the wound made to expose the pubic bone, are joined to Poupart's ligament by interrupted catgut sutures, which serve to reinforce the mattress sutures. In some strangulated herniæ, when time is short, step i. may be omitted. Without giving statistics, Professor Nicoll states that, although his operation may not give better results in mild cases, it gives much better results than those obtained by any of the older and simpler methods, *in severe cases*. He claims that it is less severe and closes the hernial aperture higher than Roux's operation; also that the amount of closure can be better regulated, and that the risks of complications arising later are much less.

8. *Roux's Operation.*—The sac is exposed and treated as in Bassini's operation. Roux then carefully drives a metal staple through Poupart's ligament and the femoral canal into the horizontal ramus of the pubis, thus closing the crural canal high up. The staple must not be hammered in too tightly, lest Poupart's ligament be torn.

Crawford Renton* speaks well of the operation, and records 25 cases. Roux is said to have performed the operation 136 times with only two recurrences (Hutchinson, *Lancet*, April 7, 1906), but no mention is made of the time during which these patients were observed, so that it is difficult to estimate the value of this statement, especially when it is remembered that recurrences usually come late in femoral hernia. The following objections have been made to the operation, chiefly on theoretical grounds. The staple may loosen with time and come away, with or without necrosis of the pubis, or may injure the femoral vessels or induce pain. Should the hernia recur, the staple may cause serious strangulation and even perforation of the intestine, like silver wire sutures have been shown to do by Macewen.

9. A flap of the pectineus and the fascia covering it may be turned

* *Contributions to Clinical Surgery*, p. 140.

up and sewn to Poupart's ligament (Watson Cheyne, *Lancet*, 1892; Salzer, *Centralblatt für Chirurgie*, 1892).

The flap is apt to waste, and the hernia may then recur. Moreover, as the flap only closes the lower end of the femoral canal, it is not surprising that the operation has been abandoned by most surgeons in favour of less severe and more hopeful methods.

In conclusion it seems to me that Lotheissen's operation, being the one most anatomically ideal, is destined to become the operation of the future, but more statistics are needed before coming to a decision. The operations of Bassini, Lockwood, and Kocher, have stood the test of time, and give very good results. It is probable that in the future the results of operations for the radical cure of femoral hernia will become as good as those for inguinal hernia.

RADICAL CURE OF UMBILICAL HERNIA.

This operation is very rarely called for in children in whom the natural tendency to cure is very great. In adults the patients usually met with—stout women of middle age, with damaged viscera, bronchitis, &c.—are not very good subjects for operative interference. Until recently the results of the operation were so bad that the name of "radical cure" could hardly be given to it.

Berger states that relapses used to occur in 15 to 25 per cent. of the small, and 30 per cent. of the large, herniæ.

Winslow (*Annals of Surgery*, vol. xxxix., 1904, p. 245) states that until recently 50 to 75 per cent. of relapses occurred in the cases of large umbilical herniæ, even in the practice of the best operators; and that 50 per cent. of the strangulated cases died.

The recent improvements in the methods of operating and the consequent amendment of the results justify a more frequent use of the operation with the object of preventing strangulation, which is attended with such fatal results in this form of rupture. It is also very important to operate early, while the protrusion is still small, for the prognosis of the operation varies almost inversely with the size of the hernia. Busse found that 75 per cent. of recurrences occurred in the cases of large herniæ, 50 per cent. in the medium-sized, and none in the small ones (from the size of a hazel nut to that of a walnut).

Suppuration had not occurred in any of these cases.

A radical cure may be performed—

(a) After the operation for relief of strangulation in suitable cases.

(b) In those rare cases of infantile hernia where the wearing of a suitable truss has not been sufficient.

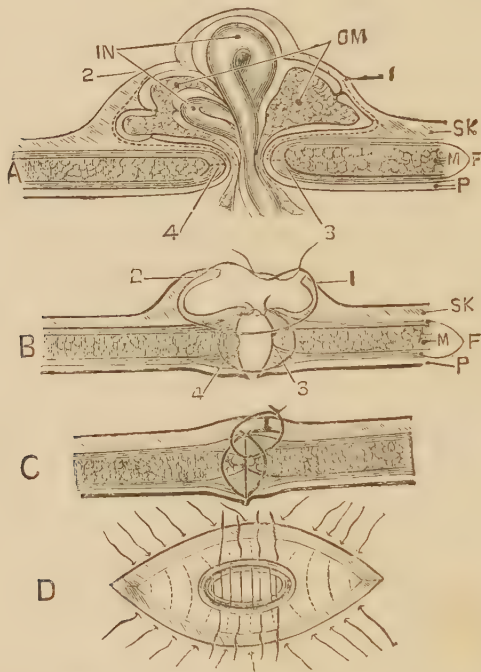
(c) In congenital hernia of the new-born child.—In these cases, either hernia into the root of the cord, or (from deficiency of the abdominal walls) partial eventrations, interference is often out of the question from the co-existence of other malformations. If the hernia be uncomplicated, and the child appear likely to survive otherwise, an attempt should be made by abdominal section to return the contents, refresh the edges of the opening, and unite them with sutures.

(d) In most cases of small and medium-sized hernia in the adult, unless the rupture is easily retained by means of a truss or a belt,

granting that the patient's general health is good enough to enable her to bear the operation, and the subsequent rest in bed.

It should be the surgeon's aim to prevent, as far as possible, the development of (i.) strangulation, and (ii.) also to prevent the growth of those large inflamed, and often inoperable, herniæ which are now to be seen far too frequently. Earlier operation in suitable cases will do

FIG. 42.



Greig Smith's method of radical cure in umbilical hernia. A, Transverse section through hernia and parietes, showing sac, contents and ring. IN, Intestine. OM, Omentum. SK, Skin. F, Fascia thickened at margin of ring. M, Rectus. P, Peritonæum. 1, Incision through skin of sac, which is continued along the sub-peritonæal tissue to the margin of the ring. 2, The same on the opposite side. 3 and 4, Incisions carried deeply through thickened fascia around the ring to expose the recti. B, Gut returned, omentum removed, superfluous skin and sac removed, sutures placed, incisions in fascia opened up, and recti exposed. References same as in A. C, Sutures tied, skin-suture to one side of parietal line of junction. D, Bird's-eye view showing double set of sutures around umbilical ring and cutaneous wound. (Walsham.)

much to avoid these serious complications. The neck of the sac may be twisted, transfixed, and tied, and even displaced as in inguinal hernia, but it is better to sew it up in most cases.

Operations.—The old operation in which, after dealing with the sac, the fibrous edges of the ring were sutured together, is to be strongly condemned, because the tension on the stitches is so great that the latter may give way or tear out, and lead to an early reappearance of the hernia and serious strangulation, or to a more certain recurrence later,

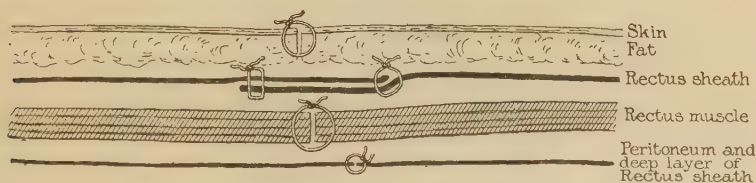
1. *Simple Suture of Separate Layers.*—In small herniæ, and especially in the infantile variety, a simple method is to explore the hernia and reduce the contents, and then, after excising the sac and its coverings, to incise the fibrous edges of the ring so as to expose the margin of each rectus muscle. The wound is then closed by separate layers of sutures, one for the peritonæum and the deep layer of the rectus sheath, one for the muscles and the anterior layer of the sheath, and one for the skin. The objection to this method is that the wound is a direct and not a valvular one, and that this makes a recurrence likely if the abdominal tension be much increased later.

2. In these cases it is clearly better to suture the various layers in the overlapping manner so strongly recommended by Winslow (*Annals of Surgery*, vol. xxxix., 1904, p. 245) (*vide* Fig. 43).

Winslow quotes Coley to the effect that Bull and Coley had twelve relapses after simple suture of separate layers in twenty-one cases of ventral and umbilical hernia.

In the majority of cases, however, the hernia is large, its coverings

FIG. 43.



The overlapping method of sewing the abdominal wall. (Modified from Winslow, *Ann. of Surg.*)

thin, and the recti widely separated and atrophied. In these it is generally impossible to keep the muscles and aponeuroses together by simple suture without undue tension on the stitches, which may tear out and lead to an early and sometimes a disastrous return of the rupture. For the same reasons Winslow's method of suture is impracticable. For these cases one of the flap operations is suitable, and Mayo's operation is by far the simplest and the best. It is based on the fact that in the subjects of umbilical hernia the abdominal wall is too long and pendulous in a vertical direction, so that it is far easier to get superior and inferior flaps than to obtain lateral ones.

3. *Mayo's Operation* * (*Jour. Amer. Med. Assoc.*, July 25, 1903).—An elliptical incision is made in a transverse direction around the hernia near its base, and the aponeurosis of the external oblique is thoroughly exposed for a distance of $2\frac{1}{2}$ —3 inches around the margin of the hernial aperture. The fibrous and peritoneal coverings are divided all round the very neck of the rupture, and the hernial contents are easily examined here, because there are rarely any adhesions at the neck.

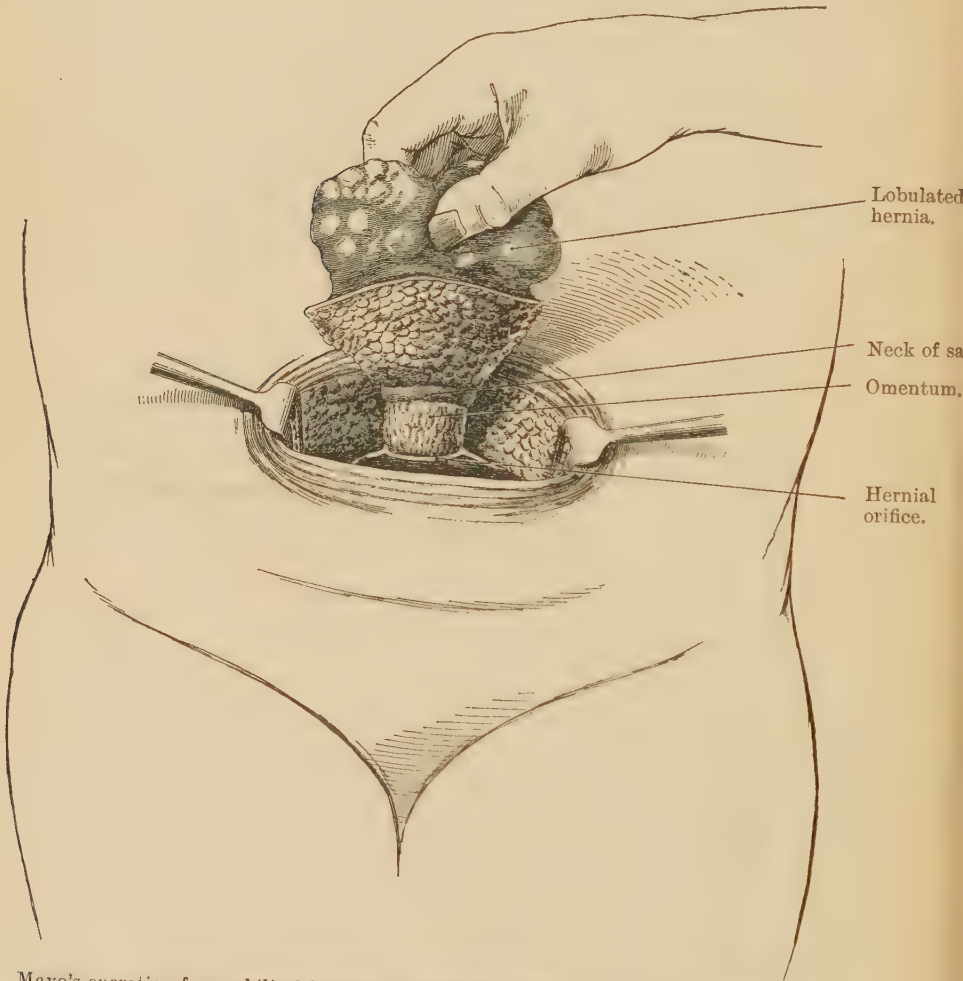
If the intestine be adherent within the body of the sac these adhesions can be more easily and safely separated by working forward along the free bowel found at the neck. This is reduced, and the omentum

* Piccolo and Sapejko have also described the operation (*Centralblatt für Chirurgie*, 1900, p. 36).

ligatured at the hernial orifice. The sac, with its thin and adherent coverings, and omental contents, are then rapidly removed in one mass without any of the troublesome and tedious dissection which is usually necessary when the sac is opened at its fundus (*vide* Fig. 44).

The hernial orifice is examined, its long axis is generally transverse,

FIG. 44.



Mayo's operation for umbilical hernia. A transverse elliptical incision has been made to expose aponeurosis and neck of sac. (*Ann. of Surg.*)

and its edges are more easily approximated by traction on its superior and inferior edges. The aponeurotic ring is widened by making two transverse incisions from its lateral poles, each extending for an inch or more outwards, thus making superior and inferior aponeurotic flaps. The peritonæum is now separated from the deep surface of the upper flap, and the lower flap is drawn up behind the upper one by means of strong mattress sutures. Before these sutures are tied, traction is

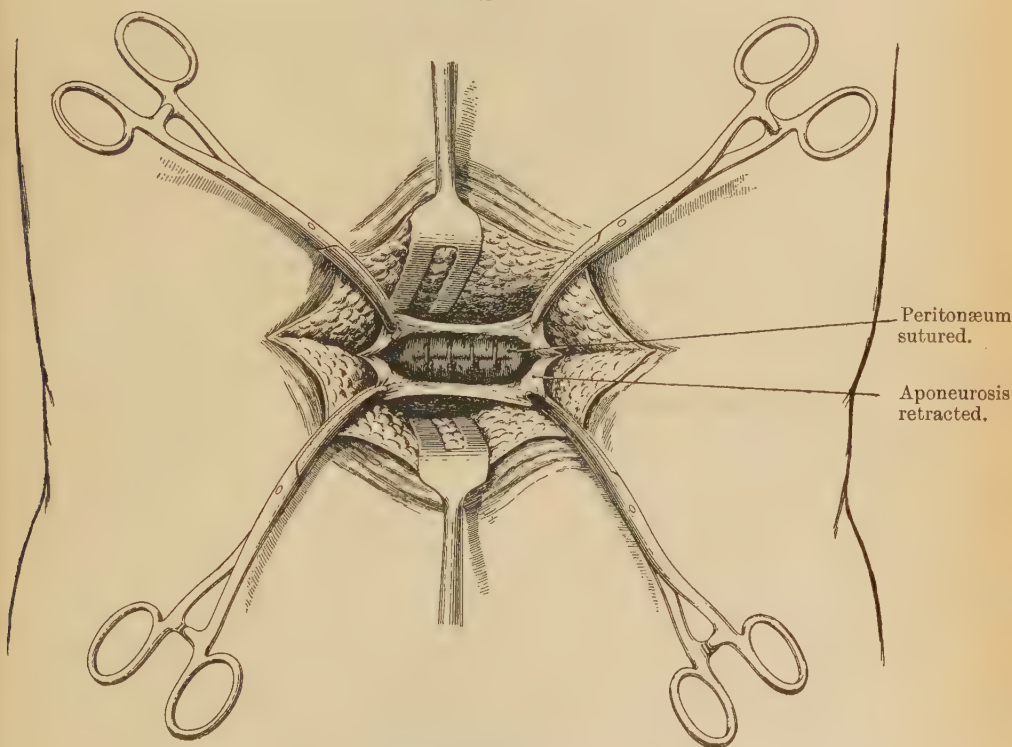
made upon them to allow the peritonæum to be closed by a continuous catgut suture (*vide* Fig. 45).

The mattress sutures are tied, and the lower edge of the upper flap is sewn to the front of the base of the lower one (*vide* Figs. 46, 47, and 48).

In some cases lateral flaps may be more easily obtained, and should then be employed.

Mayo reported thirty-five cases of umbilical hernia operated on by his method, with only one slight recurrence in one of the ten cases in

FIG. 45.



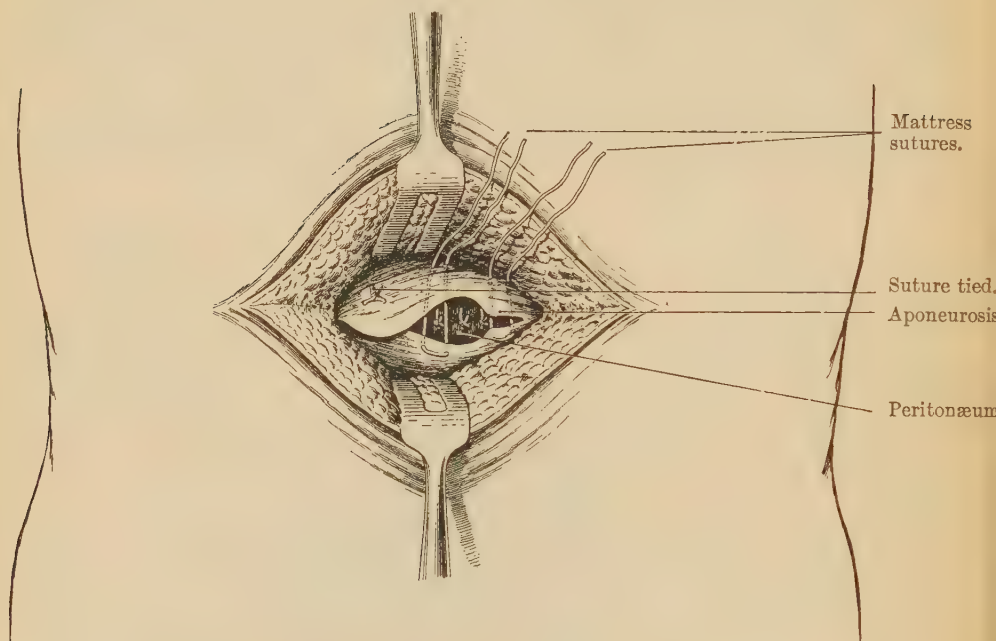
Mayo's operation. (*Ann. of Surg.*)

which he had used lateral flaps. Moynihan (*Lancet*, July 23, 1904) also publishes eleven recent cases, and strongly recommends the operation.

Although it is too early to conclude that these good results will remain permanent radical cures, yet they compare very favourably with those obtained by other methods. Busse records twenty-two operations performed in the five years ending in 1901. The mortality was 10 per cent. in all and 25 per cent. in the strangulated cases, although suppuration did not occur in any. In the fifteen cases that were followed up, there were 75 per cent. of recurrences in the large herniæ and 50 per cent. in those of medium size.

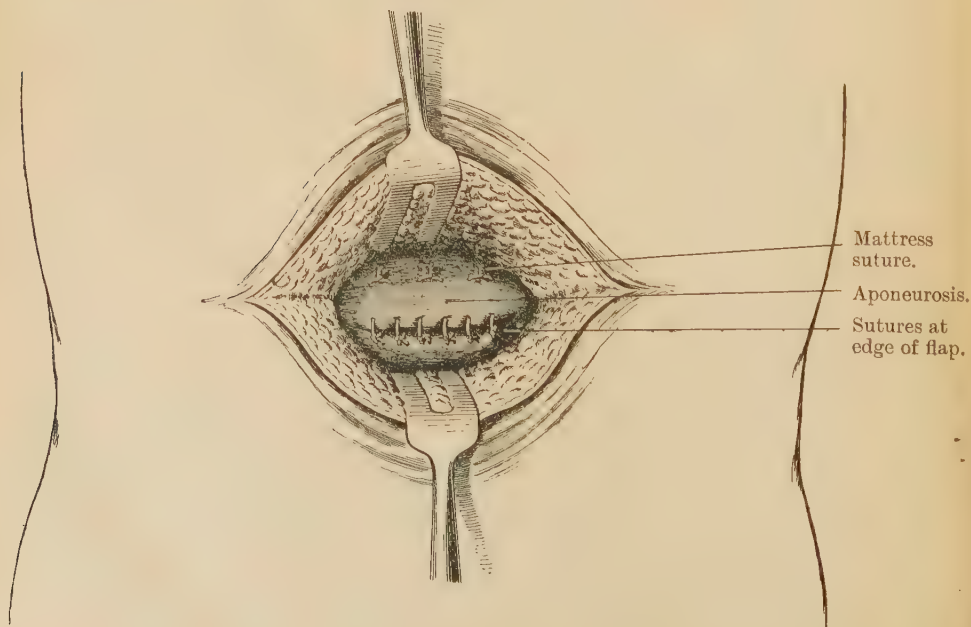
Blake (*Med. Record*, vol. i., 1901) has also independently devised and very successfully practised an operation which is very similar to Mayo's lateral overlapping method,

FIG. 46.



Mayo's operation. (*Ann. of Surg.*) Aponeurosis suture in an overlapping way.

FIG. 47.



Mayo's operation for umbilical hernia. (*Ann. of Surg.*)

Noble, Ferguson, and others, have used flaps of the anterior wall of the rectus sheath to close the hernial orifice, the base of each lateral flap being at the margin of the ring; the flaps are then rotated inwards and sutured together, so that the surfaces formerly anterior now become posterior.

Barker, Lucas Championnière, and others, have attempted to secure a broad union by inverting the edges of the hernial aperture by means of Lambert sutures passed through the anterior surfaces of the sheaths of the recti.

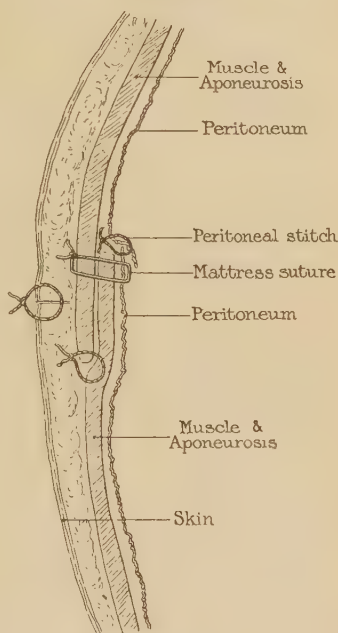
None of these operations, however, can be compared in value with that described by Mayo.

4. *The Implantation of Silver Wire Netting or Filigree.*—For very large umbilical and ventral herniæ this method has been strongly recommended by Witzel, Phelps, Willy Meyer, Göpel, Bartlett, and others.

For such cases formerly considered incurable, yet greatly in need of surgical aid, this operation may be tried if the patient's general health be good enough, and the coverings of the rupture can be rendered aseptic. A properly fitting and elastic belt should however be always well tried first, and in the majority of cases will be found sufficient. Winslow's remarks (*loc. supra cit.*) upon this subject, although somewhat too pessimistic, are well worthy of remembrance, and may be quoted in full:—"Such a mode of support" (wire netting) "has of course no anatomical basis, and but limited surgical application, though of undoubted value in those exceptional cases in which it is unfortunately appropriate. It does not appear to be appropriate as a routine treatment of hernia. Since acting as a foreign body the silver wire tends to set up suppuration and sinus formation, which weaken the wound, and defeat the very object for which the wire netting is used. The indication for the netting is to reinforce the abdominal wall in cases where, owing to thinning out of stretched structures entering into the hernial orifices or to removal of diseased tissue, normal approximation of the abdominal wall cannot be secured." Witzel (*Centralblatt für Chirurgie*, 1900, pp. 257, 459, and 1149) in his first case constructed a rude network in the wound by approximating the edges as far as possible with wire sutures and then weaving the wire amongst these sutures.

Göpel (*Centralblatt für Chirurgie*, 1900, p. 458) published an account of his work with ready-made silver wire netting, and pointed out that this method saves much time, and that the tissues are less damaged and constricted,

FIG. 48.



A section to illustrate Mayo's operation for umbilical hernia,

He reported eleven cases of umbilical and ventral hernia and seven of inguinal hernia with only two failures. The wires had to be removed in these two cases owing to the formation of blood-clots in the wounds.

Willy Meyer (*Annals of Surgery*, vol. xxxix., 1902, p. 767) reports three operations, two on very large ventral herniæ, with a very slight recurrence in each after sinus formation in one and fascial necrosis in the other. In each the recurrence came within six months of the operation, which was ultimately successful in greatly relieving the patient. The other operation was for an umbilical hernia of moderate size, and no recurrence had appeared a year later. It is probable that Mayo's operation could have been performed in this case.

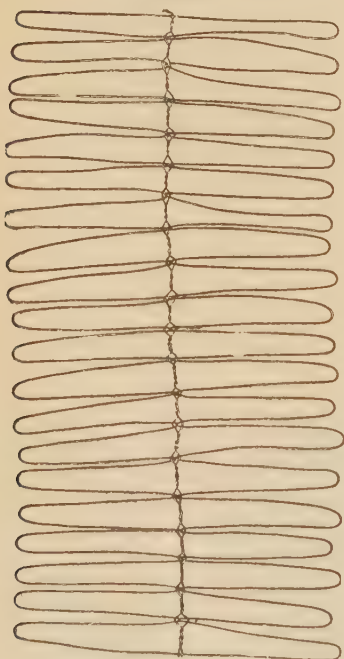
FIG. 49.



Bartlett's wire filigree.

Bartlett (*Annals of Surgery*, vol. xxxviii., 1903, p. 47) maintains that the netting generally used, consisting of wires woven at right angles to one another, is too firm and inelastic to properly amalgamate with the mobile abdominal wall. He also holds that only those wires running at right angles to the axis of the wound are necessary, for wounds only stretch laterally to any appreciable extent. Bartlett therefore employs the pliable filigree shown in the figure (Fig. 50). The cross wire prevents separation of the loops.

FIG. 50.

Wire filigree for ventral hernia.
(Bartlett, *Ann. of Surg.*)

He has operated in seven cases, six ventral and one umbilical hernia, with no suppuration, no removal of filigree, and only one partial recurrence, which occurred in a man suffering from ascites. This was Bartlett's first case.

One patient, the subject of the umbilical hernia and cirrhosis, died suddenly on the eleventh day after the operation, and the cause of death was not ascertained. The patients had not been observed long enough to justify the conclusion that the results will remain as good as they now seem. Only two of the cases had been followed for more than a year; and recurrences often come late after radical cure of umbilical hernia.

Operation.—The sac and its contents having been dealt with, the layers of the abdominal wall around the ring are dissected apart. The peritonæum and the posterior wall of the rectus sheath are separated from the deep surface of the muscles for several inches, and then sutured by a contiguous wire suture. A silver filigree one and a half times as

long as the hernial aperture, and $1\frac{1}{2}$ inch broader, is then inserted between the recti and their posterior coverings, and secured in position by a few sutures which pass round the longitudinal wire and through the rectus sheath. No attempt is made to fix the ends of the loops, for Bartlett has proved that this is unnecessary and damaging to the tissues. The loops become well secured by the granulation tissue that forms within and around them. The edges of the muscles and their fascial coverings are then drawn together as much as possible by mattress wire sutures, and if considered necessary another filigree may be implanted over the anterior sheaths of the recti, and the skin and fascia united over it.

Bartlett makes a silver netting to suit each case by twisting silver wire (gauge 27) round the ends of nails driven through a board. It is to be noticed that the net has no sharp corners or irritating angles, which might injure the tissues and lead to hæmorrhage, serous effusion, and sinus formation.

Operations for Ventral Hernia.—A ventral hernia can be treated in one of the various ways described above as suitable for umbilical hernia, and therefore no special description is called for here.

Causes of Death and of Complications which may be met with after Operations for the Radical Cure of Hernia.

1. Sepsis. 2. Peritonitis. 3. Scarlet fever. 4. Tubercular meningitis. This may occur in patients the subjects of other apparently quiescent tubercular trouble—*e.g.*, spinal caries. 5. Bronchitis due to the anæsthetic, a danger especially to be avoided in a child who has lately had measles. 6. Pneumonia. 7. Pulmonary embolism. 8. Nephritis. 9. Epididymo-orchitis. 10. Sloughing of epididymis and testicle. 11. Flatulence, with troublesome distension. This condition, so well known after operations on the interior of the abdomen, is known by some as "pseudo-peritonitis."* It is best met by aperients—*e.g.*, calomel gr. v. and Seidlitz powders, given alternately every three hours, until the bowels act; or the following enema may be useful: castor oil ʒij., turpentine ʒj., soap and water to 8 oz. 12. Recurrence. This may be due to the patient's fault, *i.e.*, his not having worn a truss when this was obviously indicated. More often it is due to faulty operating, suppuration, and the resulting thin, stretching scar, or to stitch-abscesses and sinuses, to which I have referred above.

* Where a large quantity of omentum has been tied close by the colon, the action of the latter may be inhibited, and the above complication follow to a marked degree.

CHAPTER III.

COLOTOMY.

UNDER this term are included the anterior iliac or inguinal colotomy of Littre, in which the sigmoid colon is opened in the left iliac region; that of opening the ascending or descending colon in the loin, or lumbar colotomy—an operation with which the name of Amussat* is justly associated; finally, the question of making an artificial anus in the cæcum or transverse colon is considered.

The question of the value of colotomy, compared with excision of the rectum, in cases of cancer is dealt with later on.

Before describing and comparing the different modes of performing colotomy I shall deal with those conditions which call for this procedure, then the advantages of the chief methods and the cases to which they are relatively adapted, describing finally the operations themselves.

Indications for Colotomy.—(1) Certain cases of malignant disease of the rectum. I say “certain cases” advisedly, for it is far too much the rule to recommend colotomy as soon as rectal cancer is detected, as if no other lines of treatment existed; and it is too much the habit of students, when they see an artificial anus neatly made in these cases, to think that now the patient’s troubles are over. In reality he is probably only exchanging one set of troubles for another.

Where obstruction is present, impending, or threatening, where, in cases which are too advanced for excision, there is extensive ulceration,† great pain, difficult defæcation, loss of sphincter power, profuse blood-stained or faeco-purulent discharge from the bowel, or multiple fistulae, especially recto-vesical fistula, the operation is abundantly justified.

In less urgent cases, if the surgeon be doubtful as to recommending this operation, he cannot do wrong if he lay stress on two points—one, that there is always the risk of obstruction setting in, and none can say how soon this may call for colotomy under circumstances much less

* Students are frequently perplexed as to the difference between Amussat’s and Callisen’s operations. Callisen (1796) was the first to suggest such an operation as colotomy, and planned to open the descending colon by a vertical incision. This proposal was condemned by contemporary surgeons. Amussat revived the retro-peritonæal operation, if he was not the first to perform it, but modified it by extending it to the ascending and descending colons alike, and by making use of the transverse incision. Long before Amussat’s time, Littre (1710) had opened the sigmoid flexure through the peritonæum, and in 1776 Pilloré had opened the cæcum.

† As a rule, the first time the surgeon examines a patient, the more the growth tends to become annular, the less limited it is to one aspect of the bowel; or the more it projects into the lumen in tuberos masses, the more likely, *cæteris paribus*, is obstruction to threaten.

favourable ; the other, that there is just a possibility that the operation, by diverting the fæces, will arrest the rate at which the growth would otherwise spread.

As a rule, the more complete the failure of previous treatment, the more painful, difficult, frequent, and unsatisfactory the action of the bowels, the greater the tendency to distension of the sigmoid or lower intestines generally, the more frequent the attacks of gripings and partial obstructions which herald in the termina of a complete *miserere*, the younger the patient, and thus the longer the natural prospect of active life, the more plain are the indications for colotomy. On the one hand, certain special evils* call loudly for the relief which the operation may give—viz., a patulous or invaded sphincter allowing of involuntary escape of flatus and fæces ; multiple fistulæ giving rise to foul sanious discharge, keeping the patient (perhaps a woman of scrupulous cleanliness) in a constantly filthy condition, and leading to a brawny, painful condition of the buttocks, which thus readily become the seat of cellulitis and its allies ; projection of the growth downwards through the anus, leading not only to a patulous sphincter and its consequent wretchedness, but also to irksome or painful sitting.

On the other hand, certain conditions contraindicate the operation—viz., exhaustion of strength, evidence of secondary deposits in the peritonæal cavity, liver, lungs, or pleura, extension to the inguinal glands, and absence of much pain or obstruction from first to last.

It has been too much taken for granted, because rectal cancer is often a disease of much suffering, and because, from the inefficiency or neglect of treatment, obstruction does occur, that, when cancer of the rectum is diagnosed, the patient has, therefore, agonising pain and obstruction to look forward to. The above view is quite incorrect. In a few cases cancer of the large intestine may run its course, and set up visceral deposits, and kill the patient with very little pain, and no threatening of obstruction† whatever ; in other cases—and they form a considerable number, and would be still more numerous if efficient treatment were begun early and persevered with—careful attention to diet, regular use of laxatives, daily washing out of the bowel with warm water by a soft catheter or œsophagus-tube passed *through* the stricture, followed by the injection of starch and laudanum, or a suppository of cocaine, iodoform, and morphia, will give great comfort for the rest of the day, entirely prevent obstruction, and enable the patient to get about and go to business almost to the last.

Other ever important points, on which the patient or the friends, especially if in a better rank of life, will frequently expect a decided answer, are the amount of relief, and also the amount of annoyance, which will follow the formation of an artificial anus.

The amount of relief given will depend on the amount of pain the

* To quote only two special wretchednesses—*e.g.*, when a lady cannot rise from her easy-chair without an escape of flatus or fæces taking place from a powerless sphincter ; or when a man is threatened with agonies of pain from the carcinoma eating backwards and involving the sacral nerves, and causing caries of the sacrum with fistulæ and foul discharge.

† In a few cases the growth may, instead of projecting into and obstructing the lumen of the bowel, have led by ulceration to enlargement of the gut into a cavern-like space.

patient has, the degree to which obstruction is threatening, or the presence of special miseries such as those alluded to above. Patients may be assured that any continuous pain will be greatly lessened in severity, if not entirely removed; that defæcation will become easy, painless, and, after the first four or six weeks, limited to one motion a day, save when diarrhœa is present; and that the distress of constant desire to go to stool, and tenesmus, will disappear.*

The other part of the question—the amount of annoyance following on an artificial anus—must be honestly met. There is too great a tendency amongst writers on colotomy to teach that if the operation is done sufficiently early, and if its immediate risks are survived, the relief is *always* decided, and the patient's condition *always* a most satisfactory one. This tendency has largely arisen from colotomy being so often performed on hospital patients whom it is so difficult to keep long under observation. While it is always right to remember that the disease is a mortal one, and that if a fair comparison is to be made, it must be not between the condition with an artificial anus and that of perfect health, but between an artificial anus and a bowel with incurable cancer, the patient's after-condition will be materially affected by his position in life. Where a patient's remaining days are easy, where he can continue to be careful in his food to avoid diarrhœa, where he can pay regular attention to the opening, this may give little annoyance; and it is also a rule that the greater the miseries of pain and frequent and difficult defæcation from which the patient has been relieved by colotomy, the more easily does he forget any annoyance of the anus in his relief at what he has escaped from in the past. But, on the other hand, where the surroundings of the patient compel him to try and work, the friction of any prolapsed bowel which follows on movements of the thigh and groin, the difficulty of paying attention to the opening, of avoiding diarrhœa from unsuitable food, of washing out the lower bowel—all these may mean that colotomy has only enabled the patient to exchange a life of miseries for one of annoyances—the annoyances of the opening for the miseries of the disease; annoyances certainly less important, but not the less present to the patient because they were unexpected. And, as I have said before, the less urgent the conditions for which the colotomy was done, the less the patient has been relieved from, the more actively will the annoyances of the artificial opening be present to his mind. The more frequently a surgeon performs this operation, the more readily will he admit that there are cases in which colotomy, though well performed, fails to give the expected amount of relief.

Putting aside cases where the operation is performed too late, and where the local mischief has been allowed to become too advanced, those where secondary deposits exist, cases where the opening has been too free, or where, with a proper opening, a constant cough, aided by a relaxed condition of tissues, tends to bring about a worrying prolapsus,—putting aside cases in which the opening was perhaps originally too small, or in which the patient does not take the trouble to keep the opening dilated as directed,—I am of opinion that occasionally cases of

* *I.e.*, if the opening is free, if there be a good "spur," and no fæces find their way into the bowel below.

failure to give complete relief are met with after an operation quite properly carried out. While I cannot give, and have failed to meet, an explanation for every case, I think the following are *bonâ fide* causes, and without detracting seriously from the value of this excellent operation, because only occasional, I feel that they have been somewhat unduly overlooked.

Some of these instances of incomplete relief, viz., persistent passage of motions over the malignant disease and teasing diarrhœa from the artificial and natural anus, have seemed to me to be due—(a) to the lower communication with the bowel being too patent, sometimes no doubt accounted for by the fact that the colon, at the spot where it has been drawn into the wound, owing to the shallowness of the loin or the length of the meso-colon, is scarcely kinked or bent at all : this leads to escape of fæces over the malignant growth, and much pain and teasing diarrhœa ; (b) to persistence of the growth in the bowel below, causing a profuse sanious discharge ; (c) to the growth extending upwards towards the wound, or to the bowel having been opened only just above the growth.

The question of the value (or otherwise) of colotomy as a preliminary to excision of the rectum will be discussed in Chapter XIV.

(2) Venereal or syphilitic stricture of rectum, in which previous treatment, including dilatation, has failed, and in which proctotomy* is not available.

Much of what has been written above of colotomy for malignant disease of the rectum applies to the operation here also. There is one reason for resorting to it earlier which may occasionally arise, and that is where the patient is young, and colotomy is called for by extensive ulceration, it is possible that with the rest given by the operation the above condition may be healed, and the artificial opening closed later on.

(3) Pelvic tumours—*e.g.*, enchondroma or sarcoma—pressing on the rectum.

(4) Results of pelvic cellulitis narrowing the rectum.†

(5) Vesico-intestinal fistula.

Colotomy is performed in cases of communication between the large intestine, especially the rectum, and the bladder, to prevent the passage

* Linear division of a non-malignant stricture posteriorly. If a finger cannot be passed through the stricture, this is first divided with a probe-pointed bistoury to admit the finger. Then a curved, sharp-pointed bistoury, passed through the stricture, is made to transfix the bowel beyond the stricture, and the point is brought out close to the tip of the coccyx. The parts are then cleanly divided by cutting out towards the anus in the middle line. Most strict antiseptic precautions are necessary. In about ten days the use of bougies is commenced.

† This, though rare, is occasionally an undoubted indication for colotomy. I still see from time to time a woman on whom Sir Henry Howse, over eighteen years ago, performed colotomy for urgent obstruction due to the contraction of the bowel brought about by pelvic cellulitis. More lately I have had under my care a woman, aged 23, a patient of Dr. Howell's, of Wandsworth, on whom chronic obstruction had been brought about by the same cause, dating here to the birth of an illegitimate child. The ring of contraction round the rectum was here so marked, that carelessness in diet or neglect of the use of bougies will, I am certain, lead to colotomy being ultimately called for. The possibility of the mischief in these cases being gummatous must always be remembered.

of fæces into the bladder, with its results of cystitis, agonising obstruction of urine, and passage of flatus from the urethra without notice and beyond control.

Such a fistula is much more frequently met with between the sigmoid or rectum and the bladder; if between the latter and the rectum, the communication may be found by the finger, or by passing a duck-bill speculum, or by the aid of the sigmoidoscope and injecting coloured fluids into the bladder. Too frequently malignant in character, it is occasionally of a simpler nature—*e.g.*, dysenteric, &c.,—and so, perhaps, curable. Thus, in Mr. Holmes's case (*Med.-Chir. Trans.*, vols. xlix. and l.) the ulceration between the sigmoid and the bladder was not malignant, colotomy for fifteen months was most successful, but a permanent cure was prevented by similar ulceration taking place between the cæcum and bladder, which caused death. Whether the cause is malignant disease or no, the life which lies before the patient is scarcely tolerable.

The opening is far more frequently valvular in nature—*i.e.*, while it admits of the passage of fæces into the bladder, urine very rarely passes per anum.

(6) Colotomy (iliac) is usually performed on the left side in cases of malformation of the rectum, when this part of the intestine cannot be found by a dissection in the perinæum. It has been disputed in these cases whether, after an unsuccessful exploration in the perinæum, an iliac or a lumbar colotomy should be performed. The great majority of surgeons have preferred the former operation, following here Mr. Curling (*Diseases of the Rectum*, p. 228). This surgeon pointed out that the lumbar operation was contraindicated on the following grounds:—(a) The death-rate is relatively greater; (β) the kidney, varying in size at this time of life, may, when large, overlap the colon; (γ) the colon, instead of being distended with meconium, as might be expected, is sometimes contracted and very hard to find; (δ) in addition to the irregularities in the position of the colon which have already been mentioned, a meso-colon is frequently present.*

To these reasons may be added, that an anterior incision allows a thorough exploration to be made; recently three cases have come under my notice in which the whole of the large intestine was represented by a fibrous cord with a very minute central canal, and the ileum had to be opened.

The question was raised by M. Huguier† whether, when the inguinal operation was going to be performed, the right side should not be chosen, as he considered that on this side the surgeon was more certain to reach some part of the large intestine. M. Giraldès,‡ on the other hand, has stated that all the inquiries undertaken to elucidate this subject tend to show clearly that the surgeon may rely on nearly always finding the sigmoid in the left groin. "Numerous anatomical investigations, together with the

* Mr. Curling (*loc. supra cit.*) gives the results of twenty dissections on the bodies of infants, both operations having been first performed. In eighteen out of the twenty, Littré's operation was found easy, whether the bowel was distended or no. In two, this operation failed, as the colon crossed the spine to run down, on the right side, into the pelvis. In eight out of the twenty subjects, lumbar colotomy was easily performed, without opening the peritonæum. In six, the operation was "more or less difficult," and, as Mr. Curling remarks, the difficulties would have been increased in the living. In six, lumbar colotomy was impossible owing to the distinctness and looseness of the meso-colon.

† *Bull. de l'Acad. de Méd.*, tom. xxiv. p. 445.

‡ *Lect. Clin.*, p. 121, quoted by Mr. Holmes (*Dis. of Children*, p. 179).

records of those of Curling and Bourcart, have shown me that in the great majority of cases in the fœtus and newly-born child the sigmoid flexure is placed on the left, and not on the right. In 134 autopsies below the age of a fortnight I found the sigmoid flexure on the left side in 114; in 50 cases of Littré's operation which I have collected the operator always met with the sigmoid flexure on the left side; in 30 post-mortem examinations of infants operated on for imperforation the intestine was always found on the left; in 100 examinations of new-born children Curling found the sigmoid flexure on the left side 85 times; and Bourcart, who made prolonged researches in order to elucidate this question, found the sigmoid flexure in its normal position 117 times out of 150."

(7) Tuberculous disease of the rectum if extensive occasionally demands a temporary colotomy; the rest so obtained may be of great value, and the artificial anus may be closed later in some cases.

(8) Dysenteric ulceration and stricture. The treatment of dysentery leading to stricture is rare; when it occurs, ulceration may extend so high up the large intestine as to make even a right-sided colotomy of doubtful value. A case of colitis (the nature of this is not explained) with ulceration, treated by inguinal colotomy and local treatment of the ulcerated surfaces, with subsequent closure of the artificial anus, is recorded by Mr. Mayo Robson (*Clin. Soc. Trans.*, vol. xxvi. p. 213). In patients who give a history of long-standing dysentery and stricture, dysentery is often the result and not the cause of the stricture.

(9) Annular stricture of the sigmoid colon, practically always carcinomatous.

(10) Malignant disease of the large intestine higher up—viz., in the splenic or hepatic flexures. Here colotomy may be performed as a temporary measure preparatory to the removal of the growth which has caused acute obstruction.

(11) Membranous colitis and ulcerative colitis. Mr. Golding Bird and Dr. Hale White have described three cases of membranous colitis in which right lumbar colotomy was performed, and one case of chronic dysentery in which cæcostomy was employed (*Clin. Soc. Trans.* 1896 and 1899). They have also given the more valuable subsequent histories of these cases (*Clin. Soc. Trans.*, 1902).

Case i. Female æt. 30, of neurotic temperament, had suffered from chronic mucous and membranous colitis for ten years. The right lumbar colotomy was performed, and a spur soon formed so that no fæces entered the ascending colon. The symptoms all disappeared, and the colotomy was easily closed after five weeks; the patient remaining quite free from symptoms of colitis until her death, two months later, from general peritonitis of uncertain origin. A small pelvic tumour existed, which may have contained pus and ruptured.

Case ii. Female æt. 36 had suffered from severe membranous colitis for twenty years. In May, 1896, right lumbar colotomy was performed in two stages, and the patient improved very much in her general health, but she still passed a few casts, but otherwise she had not a bad symptom when in May, 1897, the colotomy was easily closed. In November, 1898, she was quite well and leading an active life, but had to take aperients. In February, 1902, she had rheumatic fever, and the patient's mother, replying to an inquiry, stated that "she has to admit that there is very little change in her condition compared with that before operation, and she could not candidly say that there is a perfect cure." "The general health is very bad, occasionally swelling attacks (tympantites), great wasting of the body; the food passes through undigested, accompanied by casts and blood occasionally. . . . There is considerable constipation." The relapse began in December, 1898.

Case iii. Female æt. 31, a barmaid, had suffered from symptoms of severe colitis for eighteen months, passing much membrane. In March, 1898, right lumbar colotomy was performed in two stages, with an interval of five days. This gave great relief. A weak solution

of lysol was injected into the colon on two occasions, but this was followed each time by a return of the symptoms, and casts were passed; the same thing occurred in the second month, when, owing to the formation of a keloid, the wound contracted and some faeces escaped up the colon. The patient left the hospital after four months, and she was then in excellent health. It was proposed to close the artificial anus after a year, but the patient was anxious not to hurry and so run any risk of a relapse.

No difficulty was experienced in closing the artificial anus in September, 1900, two and a half years after it was made.

During the two and a half years in which the fistula remained open the patient kept in perfect health, resuming her business as a barmaid six months after the artificial anus was made, and subsequently continuing her occupation without interruption. She suffered no inconvenience from the protective apparatus she wore over the opening. During the eighteen months that have now elapsed since the closure of the wound she has remained in perfect health, following her usual occupation. She was taken into Guy's Hospital in November, 1901, for a short time, and all the motions were examined, and found to be perfectly natural.

Case iv. Male æt. 35 had suffered from symptoms of chronic colitis (probably dysenteric) for seven years. In December, 1898, the cæcum was opened through an inguinal incision, the bowel being first sewn to the parietes; it did not allow of being pulled out sufficiently to pass a rod or anything else behind it; the operation was performed in two stages with an interval of five days.

Owing mainly to the fluidity of the contents of the bowel, it was found impossible to prevent a little motion now and then passing into the colon; but after the external opening had been somewhat enlarged, and a suitable plug fitted, faeces got more seldom into the colon; but throughout the case up to the time of the man leaving the hospital some motion would escape that way once in two or three days. To try to prevent this, a Paul's tube was inserted into the ilco-cæcal valve, which was easily felt opposite the artificial opening in the cæcum; it, however, did not answer, and was invariably and quickly extracted. A rubber plug attached to a shield so made as to block the ascending colon as far as possible was found to answer best. After seven weeks the patient left the hospital to return to work much improved in his general health and having lost all his symptoms of colitis.

During the summer of 1899 he worked hard as an artisan at Woolwich Arsenal, and as he continued perfectly well, was anxious for an early closure of the wound. Two attempts were therefore made during 1899, but neither was successful, though the opening was much reduced in size. Since the second of these attempts very nearly all the faeces have passed naturally through the colon and rectum in a perfectly healthy way, only a little occasionally coming through the colotomy wound. A third and last attempt was made in 1901, but again with only partial success. But on February 25, 1902, he presented himself in good health, and reported that the small sinus resulting from the last operation had closed by itself. It will be noticed that he has remained well for two and a half years after the passage of faeces along the colon has been re-established.

Other cases may be very briefly mentioned.

Case v. Messrs. Keith and Simpson (*Med. Press*, July 24, 1896), quoted *Trans. Clin. Soc.*, 1899, publish an account of an apparently right colotomy performed in June, 1894, on a woman æt. 34, with four years' history of membranous colitis. The wound was kept open for seven months and then closed. A perfect cure is recorded.

Case vi. Dr. Lawrie, of Weymouth (*Brit. Med. Journ.*, November 5, 1898). The patient was 47, and had a history of membranous colitis for eleven years. Cæcotomy was performed in January, 1897. The report says that the cæcum was able to be drawn out of the wound and a rod to be passed through its mesentery. The wound was kept open seven months. The last note of this case is in February, 1898, and a cure is claimed.

V. Curl mentions several cases of moderately severe dysentery treated by cæcostomy with hopeful results (*Ann. of Surg.* 1906, vol. xliii. p. 543).

It may be concluded from these cases and others, that right lumbar colostomy may be beneficial in the treatment of chronic colitis, and

that the operation is better than cæcostomy because the diseased colon is granted a more complete rest; the discharges are more solid and less frequent owing to the absorption of fluid in the cæcum. The skin around the fistula is less apt to get inflamed; the artificial anus is far more easily closed, but it is not so accessible for the necessary but less frequent attentions of the patient.

The absorption of water and some nourishment in the cæcum is a distinct gain in feeble patients. Mr. Golding Bird believes that complete rest to the colon is more valuable than irrigation. The time of closure must not be too early, certainly not under six months, and probably not under a year in most cases.

Mr. Golding Bird considers that colotomy is preferable to ileo-sigmoidostomy in these cases for several reasons: the anastomosis may not be above the disease, which may extend to the pelvic colon in some cases, and the fæces in time regurgitate into the diseased colon above and set up more trouble. He also thought that diarrhœa would probably occur; since then it has been shown that diarrhœa is only temporary and rarely troublesome in ileo-sigmoidostomy. The other alternatives of treatment are valvular cæcostomy and appendicostomy with irrigation, which are discussed later on (*vide* p. 141).

The writer knows of one case of membranous colitis for which the whole of the diseased colon was excised; the patient died.

Of the above 11 conditions, the first five will usually be treated by inguinal colotomy, this operation being preferred for the reasons mentioned below (p. 126), as long as the abdomen is undistended. The operation chosen in the eighth must depend on the height to which the disease has extended. In the ninth the surgeon will be justified in cutting down upon the sigmoid colon, with the intention of excising the disease if possible, or opening the bowel above it, and if the sigmoid be found empty to enlarge the incision sufficiently to allow the hand to be introduced for exploration. It is not easy, however, to explore the whole abdomen from this region. In the last two it will be needful to open the colon high up. It will be well to discuss here the difficulties which often arise in deciding as to—

The Site of the Proposed Colotomy.—In the above cases, especially where intestinal obstruction is threatening from malignant disease with distension and tympanites, the surgeon, particularly if the history is deficient or misleading, may be in doubt as to the site of the disease, and therefore where to operate. It is quite impossible to make fixed rules for advice, but the following points will help in doubtful cases. Before specifying them I would call attention to two points: one, that malignant disease quite low down—*e.g.*, in the sigmoid—may, by a sudden onset of obstruction, simulate an acuter condition of things higher up, the patient being too ill, or otherwise unable, to give an account of previous threatening and finally culminating obstructions. Here the following alternatives lie before the surgeon: (1) to explore the site of obstruction through one rectus near the middle line: this is by far the best method; (2) to cut down upon the sigmoid flexure in the hope that the obstruction may be in this neighbourhood, a very common place, and if the sigmoid be found empty to enlarge the incision sufficiently to allow the hand to be introduced for exploration; it is not easy, however, to explore the whole abdomen from

this region, and the risk of prolapse of the colon is increased by enlarging the incision: moreover, another incision may have to be made to open the colon on the right side unless an ileo-sigmoidostomy be performed; (3) to perform right lumbar colotomy, so as to make sure of relieving any obstruction further back—*e.g.*, in the splenic or hepatic flexures. Unless it be certain that the obstruction is in the colon, this course is not recommended, for the ascending colon may be found to be empty, as in a patient who was later found to have a gall stone in the ileum. In all doubtful cases it is better to make the incision near the middle line, so that a thorough exploration can be made. I would here warn my junior readers on two or three points. If they decide first to explore by abdominal section, and find a growth in the colon, descending or ascending, they should not, even if the meso-colon admits of it, bring the bowel into the middle line and open it. Making an artificial anus in the colon by a median incision is usually a matter of difficulty, the bowel not coming sufficiently up into the wound (this does not apply to the transverse colon), thus the skin has to be forced down to it, causing tension on the sutures, giving way of these a little later, and either disastrous results or a most unsatisfactory opening. Even if it were usually easy to carry out the above course, I do not consider it would be good surgery, as such displacement of the large intestine may lead to acute obstruction of some loop of the small intestine later on.

I also advise against opening the cæcum if this can be avoided. Owing to the more liquid nature of the fæces here from the close proximity of the small intestine, though the patient's nutrition will not suffer, the skin in the neighbourhood of the artificial anus is liable to most troublesome excoriations and ulceration.

In cases where the surgeon is in doubt as to the exact site of the disease, but suspects from the age of his patient, duration of the trouble, history of "indigestion" with unsatisfactory action of the bowels, number of attacks of threatening obstruction, &c., that the mischief is somewhere in the large intestine, attention to some of the following points may be useful:

(1) *The proportionate frequency of stricture in different parts of the large intestine.* The frequency of disease in the rectum and sigmoid flexure, as compared with any other part of the large intestine, and, generally speaking, the frequency of disease in the left side of the arch formed by the large intestine, as compared with such disease in the right side, are well known.*

(2) *Examination of the rectum.* It must be remembered that a growth in the rectum may not be discovered by the usual digital examination made with the patient lying down, whereas it may be felt when the patient is in the sitting attitude and straining; this brings more than another inch of rectum accessible to the finger, and when an annular growth exists high up, it often becomes intussuscepted into the ballooned rectum below, and may be felt when the patient sits

* Dr. Fagge, in drawing attention to this fact (*Guy's Hosp. Reports*, 1868, p. 314), quoted the following statistics from Dr. Brinton:—"Of 100 cases, 4 are in the cæcum, 10 in the ascending colon, 11 in the transverse colon, 14 in the descending colon, 30 in the sigmoid flexure, and 30 in the rectum." The statistics of Dr. Fagge and M. Duchaussoy confirm the above.

upon one buttock. Occasionally also a growth of the pelvic loop of the sigmoid flexure may be felt through the anterior wall of the rectum. The sigmoidoscope may reveal a growth in the upper part of the rectum or the lower part of the sigmoid colon.

(3) *The form of the abdomen* may help to valuable conclusions. Thus, Dr. Fagge (*loc. supra cit.*, p. 319) gives a case of cancer of the hepatic flexure in which it was observed during life that the cæcum and ascending colon were distended, and not the descending colon. Again, he observes that when the rectum or the sigmoid flexure is the seat of obstruction the lumbar regions and the epigastrium are no doubt generally prominent, and the course of the colon is more or less plainly marked out. That these conclusions are only valuable if not too implicitly relied upon is shown by the fact that cancer of the rectum may be present, with vomiting, peristalsis, and borborygmi, and yet there may be no general distension of the abdomen, no filling out at all of its sides; on the other hand, a prominent epigastrium, and the appearance of a large horizontal coil of intestine here, may lead to the conclusion that the transverse colon is distended, the disease being, nevertheless, in the ileum, a distended coil of which has rivalled the colon itself.

A patient observation of the abdomen for peristalsis, which may be stimulated by flicking the abdominal wall with a wet cold towel, may sometimes enable the surgeon to localise the site of the obstruction almost accurately.

(4) A symptom of some value, if verified by the medical man himself, is the fact that for some time the *motions* have been *narrow, tape-like, broken up, abnormal in bulk, shape, and length*. This symptom generally points to a growth in the rectum or sigmoid. Certain fallacies diminish, however, the value of the above—*e.g.*, that in cases of stricture high up, as in the upper part of the sigmoid flexure, there is probably room for the fæces, after they have got through the stricture, to collect, till their characteristic form is given them, though we do not know how far irritation of the intestine and formation of mucus at the seat of the growth may interfere with this.

(5) *The frequent passing of "blood and slime"* also generally indicates a growth low down in the large intestine. When the symptom is only terminal in a case of chronic obstruction it probably means that the growth has become intussuscepted; in a recent case this sign, associated with pain and tenderness and dulness in the left flank, enabled the writer to conclude that an intussusception of a growth at the splenic flexure had occurred.

(6) A few other points—*e.g.*, constant *arrest of borborygmi at one spot, fixed pain at one spot*, as in the right hypochondrium—may give useful indications. The use of large injections is mentioned only to be condemned as unreliable and dangerous. It is unreliable because some of the fluid may pass through the stricture, and it is dangerous for the same reason, for the distended colon, especially the cæcum, may be ruptured from the increased distension of the intestine, often the subject of "distension ulcers." Moreover, it is painful and wastes precious time.

The distance to which a long bougie or rectal tube passes is of very little value, and needs only this briefest mention here because the surgeon is still sometimes called to cases in which he is assured that

the obstruction cannot be in the rectum or low down in the sigmoid flexure, as a long bougie has been easily passed its full length. This fallacy, which is due to the bougie bending on itself, is more frequent than the other one in which the arrest of a bougie by one of Houston's folds misleads into the belief that a stricture exists low down. The sigmoidoscope is far more reliable, and it is practically safe unless carelessly passed without its obturator. If, after weighing the above, the surgeon is still in doubt as to the exact site of the disease of the large intestine, he should not hesitate to open the abdomen near the middle line and explore for the site of the disease, and then decide on the line of treatment to be adopted.

LUMBAR OR POSTERIOR COLOTOMY.

Though this operation has of late years been practically replaced by the iliac method, it deserves attention as the operation first largely employed, and as one that may still be resorted to under certain rare circumstances of difficulty. A right lumbar colotomy may sometimes be performed in preference to appendicostomy or valvular cæcostomy in the treatment of cases of chronic colitis (*vide* p. 115). The indications for colotomy have been already given at p. 110, and a comparison of the lumbar and iliac methods will be found below at p. 126.

Landmarks (Fig. 51).

1. The lower border and tip of the last rib. 2. A point half an inch behind the centre of the crest of the ilium, this point being found by accurate measurement along the crest between the anterior and posterior superior spines (W. Allingham). 3. A line drawn vertically up from the last-mentioned point to the last rib. This gives, with sufficient correctness, the line of the outer edge of the quadratus, and the position of a normal colon. Owing to the varying length of the last rib, the upper end of this line may meet this bone at its tip, or at a spot a varying distance in front of or behind this point. It is well to dot the ends of this vertical line with an aniline pencil. The dint of a finger-nail, made when the patient has been brought under the anæsthetic, will mark these points sufficiently to begin with, but a little later, in a difficult case, the surgeon may be glad of having taken every possible precaution.

Incisions.

1. Vertical, of Callisen. This at first sight is the best, as it follows the above line, and thus corresponds anatomically to the colon, but it has the disadvantage of giving but limited space, especially in a fat or deep-chested patient; and, if prolonged upwards, so as to give all the space possible, it divides the intercostal vessels running with the last dorsal nerve, and gives rise to troublesome hæmorrhage. 2. Transverse, of Amussat. 3. Oblique, of Bryant, modified from the above. One of the two latter is usually employed; they have the great advantage of being readily prolonged when more room is required, and the oblique incision corresponds better with the course of the nerves and vessels.* It is the one given below.

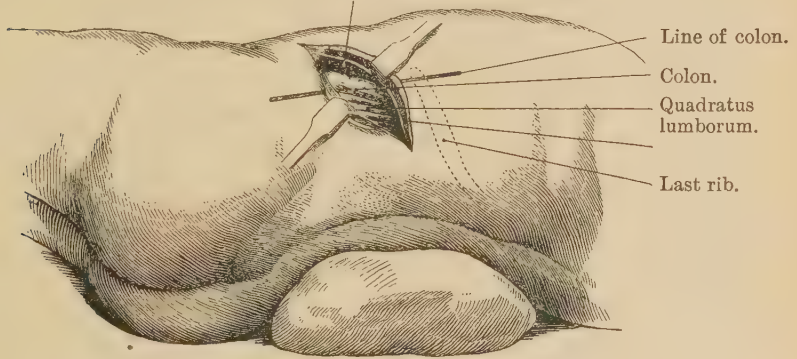
* The late Mr. Greig Smith (*Abdom. Surg.*, p. 396) gave the following practical hint:—"In thin patients, and particularly in women, whose iliac crests are more

Operation (Figs. 36—39).—The patient being turned on to his side (most usually the right), with a firm pillow under the loin, the parts cleansed, the tip of the last rib and the point on the crest of the ilium, as given above, being dotted with an aniline pencil, an incision is made, beginning $2\frac{1}{2}$ to 3 inches from the spine, according to the size of the erector spinæ a little below the last rib, and running downwards and forwards for $3\frac{1}{2}$ to 4 inches towards the anterior superior spine. The centre of this incision should bisect the line given above as the line of the colon.

The first cut should expose the muscles, the skin in the posterior half being thick, and the subcutaneous fat often abundant. The next may go well into the muscles, the remainder of which should then be carefully divided with the knife, so as to expose the fascia lumborum; any bleeding vessels being now secured, this fascia is pinched up,

FIG. 51.

Peritoneum.



Lumbar colotomy.

nicked, and slit up on a director. Two retractors being placed on the lips of the wound, the fat which lies around the kidney and behind the fascia lumborum is next torn through and pulled away with the fingers. If the bowel is distended, it will bulge up into the wound, pushing before it the transversalis fascia, and the operation can be readily completed. If, on the other hand, the bowel is empty, the real difficulties of the operation only begin at this stage. The wound being well opened, the kidney, if it come down below the rib (as it occasionally does, especially in a patient breathing heavily under the influence of an anæsthetic), being kept out of the way by the finger of an assistant, the intestine is sought for by scratching with a director, or two pairs of forceps, through the transversalis fascia (Fig. 51), exactly in the line to which attention has been already drawn. Several layers of cellular tissue may be met with here, and it is now that most of the difficulty is usually met with, owing to the

prominent than in men, there is a tendency for the upper lip of the wound to fall inwards, while the lower lip protrudes. This may be obviated by careful apposition, and by not bringing the line of the incision too close to the ilium."

operator being afraid of the peritonæum, and to his not opening the transversalis fascia with sufficient decision. Unless this point is attended to, the colon cannot bulge satisfactorily or be drawn up into the wound.

When this has been done, scybala in the colon will in many cases be felt; but if the large intestine is empty, much trouble may be met with in detecting it and getting it up into the wound, especially if, close by, the peritonæum is bulging up.

At this stage the following points may be usefully remembered:—

(a) The exact position of the line of the colon (p. 120). (b) The lower end of the kidney, and its relation to the colon. (c) The outer edge of the quadratus lumborum (p. 120). (d) The sensation of thickness as given to the fingers in pinching up the colon, thus distinguishing large from small intestine. (e) The feel of scybala if present. (f) Seeing one of the three longitudinal muscular bands which distinguish the colon.* (g) Inflation with air or injection of fluid.† (h) Mr. Bryant has advised rolling the patient over on to his back at this stage, so that the colon may be felt to fall on the finger inserted deep into the wound.

The bowel having been found, its posterior surface is to be drawn well up into the wound. This is one of the weak points of the lumbar operation. Owing to the shortness of the meso-colon and the fixity of the bowel, especially when distended, it is very difficult to get the bowel out of the wound sufficiently to make a satisfactory “spur.” Unless this is done, there is a risk of the patient having a fecal fistula instead of an artificial anus. If the case is not an urgent one, the bowel, when well pulled up, may be retained there by means of a rod passed beneath it. If the shortness of the meso-colon prevents the use of a straight rod, this must be suitably curved, so that the bowel may still be kinked, but without undue tension. The margins of the wound are then carefully closed with salmon gut sutures, and a few fine ones may be passed between the bowel itself and the margins of the wound. The usual antiseptic dressings are then applied, iodoform being dusted over the bowel and wound. These dressings will probably not need

* Mr. H. Allingham (*Brit. Med. Journ.*, April 28, 1888) seems to consider it very difficult to ensure finding one of these bands without opening the peritonæal cavity. While I should be the last to make light of the difficulties which may beset this operation, I feel sure that few surgeons, who have had a large experience of colotomy, will agree that the above step is needful, especially if the line given by Mr. Allingham's father be strictly followed. Where the operation is done in two stages the peritonæum may be opened, if needful, without any drawback. But where the bowel must be opened at once—and this will be the rule in lumbar colotomy—any injury to the peritonæum is to be avoided. The aphorism quoted at p. 61 is to be remembered here also.

† Air is most readily made use of. It may be pumped in by a Higginson's syringe, a Lister's hand-spray, but, best of all, by the special apparatus described by Mr. Lund (*Lancet*, 1883, vol. i. p. 588), which, by means of an elastic ring, secures air-tight contact with the anus while air is being pumped in, either as an aid in colotomy or as a means of reducing an intussusception. In some cases of cancerous disease of the rectum it will be very difficult to introduce any nozzle for inflation beyond the disease. In the summer of 1885, when performing colotomy at Guy's Hospital in a patient the lower part of whose rectum had been unsuccessfully excised at another hospital, I found it impossible to introduce any nozzle when desirous of inflating an empty colon.

changing till the second or third day, when the operation is completed by opening the bowel with a tenotomy-knife, or sharp-pointed pair of scissors. This opening may be a small crucial one. Very little but flatus will pass at the time, but a director will show the presence of fæces, and mild aperients may be given as soon as the parts are firmly healed.

The method of performing colotomy by two stages was introduced at Guy's Hospital by some of my senior colleagues, Mr. Bryant, Mr. Howse, and Mr. Davies-Colley, being based on that most important modification of gastrostomy which Mr. Howse was the first to make use of in this country, Mr. Davies-Colley bringing before the Clinical Society, in 1885 (*Trans.*, vol. xviii. p. 204), a paper on "Three Cases of Colotomy with Delayed Opening of the Intestine." The great advantages of this two-stage method are (1) that it defers the opening of the bowel till this is sufficiently adherent. (2) By this delayed escape of intestinal contents the gravity of any injury to the peritonæum at the time of the operation is very much diminished. (3) The second great trouble after colotomy—that of burrowing suppuration up and down the planes of cellular tissue, which have of necessity been freely opened—is done away with. The opening of the intestine being delayed, primary union, to a very large extent, can be secured, especially with the aid of deeply-passed sutures, or of chromic gut ones cut short and dropped in, and dry dressings.

But, nowadays, under the conditions in which lumbar colotomy is usually resorted to—viz., obstruction and distended intestine—it will be necessary to complete the operation at one stage. Here the distension, and the difficulties consequent upon it, are best met by tying in a Paul's tube. The wound having been closed as far as is possible, the intestine is drawn out, and the surrounding parts are shut off with sterile gauze; a small opening is then made in the clamped intestine, the tube inserted and tied in, and the patient turned on to his back while the chief of the accumulation in the intestine is allowed to run away safely. When sufficient relief has been given, the bowel may be additionally secured by some sutures between it and the lips of the wound. The wound having been carefully shut off with dressings, the fæces are collected by means of india-rubber tubing fitted on to the tube, soiling of the dressings, &c., being prevented by jaconet.

Difficulties in Lumbar Colotomy.

1. An empty bowel.* This has been already alluded to (p. 121).
2. Mistaking bulging peritonæum for colon, and opening it. This may be due to the surgeon forgetting the line of the bowel, and working deeply too far forwards; or it may take place from no fault of the surgeon, being due to the presence of a meso-colon, or to the

* It is noteworthy that the intestine may be found empty even in obstructions of long continuance. Thus, Mr. Curling (*Diseases of the Rectum*, p. 182) writes: "In a case of carcinomatous stricture of the rectum, in which I performed colotomy after a month's obstruction, in a woman aged 40, not only was the colon contracted, but it was actually compressed against the spine and put out of the way by the distended small intestine, so that it was impossible to reach the bowel without opening the peritonæum. No inflammation or unfavourable symptom resulted." It would have been interesting to know whether more than one obstruction did not exist in the large intestine in this case.

extremely contracted condition of the colon.* It by no means always causes peritonitis. When this accident has happened, as shown by the escape of a little serous fluid, the appearance of a coil of small intestine or of omentum, the opening should be at once taken up with dissecting-forceps and tied round with carbolised silk or chromic gut, and a little iodoform rubbed round the ligature. If the opening be larger, it must be closed with catgut sutures. 3. A very fat loin. This is not a very uncommon source of difficulty in elderly people who require colotomy. It must be met by a very free incision in which all the tissues are cut equally throughout (*i.e.*, not making a conical wound deep only in its very centre; this not only adds to the difficulty of finding the bowel, but also of retaining it *in situ* afterwards). To meet the additional tension and tendency of the gut to drag away in these cases, it must be more carefully secured by close stitching, especially if it is necessary to do the operation in one stage, every care being taken to prevent extravasation of fæces into the surrounding cellular tissue.† In fat people the surgeon must be prepared not only for much subcutaneous but for abundant extra-peritonæal fat also, coarse, and difficult to dissect in. If, in such a case, the colon is contracted, there are few more difficult operations. 4. Presence of a meso-colon. This may be a cause of much difficulty and doubt, and render opening of the peritonæum necessary. Where this is the case, the surgeon should always defer opening the colon if possible.

Mr. Jessop (*Brit. Med. Journ.*, 1879, vol. ii. p. 614) mentions cases in which, owing to the presence of the above, he was obliged to open the peritonæal cavity and incise the gut through its peritonæal coat. The cut edges of the bowel, brought through the opening in the peritonæum, were stitched to the skin as in the ordinary operation. No bad effect followed. Mr. Bennett May (*Brit. Med. Journ.*, 1882, vol. i. p. 940), operating on the right side, found an empty colon, "and it was only by keeping strictly in Allingham's line, and patiently searching there between the layers of a great length of meso-colon, that the intestine was reached, collapsed and empty."

5. Abnormality of colon. Every surgeon must remember cases in which the descending colon, though present, was displaced, and came down in the middle line. Occasionally part of the large intestine is actually absent.

Mr. Lockwood (*St. Barthol. Hosp. Reports*, vol. xxix. p. 256) mentions three cases in which the colon could not be found; in two its absence was verified at the

* In a case in which, owing to the extreme pain during defæcation, the patient had dreaded any action of the bowels, and had eaten very little, the colon was much contracted and lay far back. In trying to find it, I opened the peritonæum, and omentum protruded. A carbolised sponge was kept over the opening while the colon was found, the opening then tied up with chromic gut, and the colon not opened for four days. No ill result followed. As in supra-pubic lithotomy, the peritonæum may give way during vomiting. Thus, Dr. Walters (*Brit. Med. Journ.*, 1879, vol. i. p. 212) was stitching the colon to the wound when "the patient retched violently, causing the peritonæum to give way, and a coil of intestine to protrude from the anterior part of the wound. This was immediately covered with warm sponges, cleansed from the faeculent matter it had acquired by contact with the open colon, and returned." When, five weeks later, the patient sank from exhaustion, no trace of peritonitis was found at the necropsy.

† As much of the wound as is possible should be closed before the intestine is opened.

necropsy, both on the right side. One of these cases is reported fully. The following are the main points :—Owing to obstruction of the large intestine, the site of which was doubtful, it was decided to cut down on the right colon. No colon could be found, and, relief being imperatively demanded, the peritonæum was opened and a loop of small intestine drawn outside the wound. Death occurred four hours after the operation, and at the necropsy the right colon was quite absent,* the cæcum being found behind the liver in the right hypochondrium, the large intestine extending from this to the splenic flexure in the usual manner,

6. Malignant disease at the site of colotomy. This is best met by performing colectomy in appropriate cases, or by performing colotomy on the opposite side. 7. The kidney may be embarrassingly low. 8. The peritonæum may be so pushed back by ascitic fluid that it is impossible to open the gut without injuring the peritonæum (Pepper, *Lancet*, vol. i., 1888, p. 772). 9. Cases where the operation has to be completed at once, and the colon is much distended with fæces, will give much trouble (p. 123).

Troubles which may be met with after Colotomy.

1. Too large an opening in the bowel. This may lead to prolapse of the mucous membrane. If this take place to a large extent it is a great nuisance to the patient, owing to the moist, excoriated, bleeding surface which results, difficult to keep up by any apparatus. Even where the opening has been small, a good deal of prolapse may take place if there is much cough and a flaccid condition of the side.

2. Too small an opening in the bowel. This is of much less moment, as it can be readily dilated by tents. Of these, laminaria are much the most efficient; two should be inserted at a time, to effect rapid dilatation. Then the opening is easily kept patent by the occasional insertion of the little finger, or by the wearing of a proper plug. (See also p. 134.)

3. Teasing descent of scybala into the bowel below the artificial anus. This, which often renders a colotomy disappointing, is best met by bringing the colon sufficiently into the wound at first, and by keeping patent an adequate opening. If scybala still find their way down, the colon may be washed out from the anus or the wound. If these fail, the only course, and one not devoid of risk, is to open up the wound, to divide the bowel, and attach the upper end in the wound, and then to displace and fix the lower end well away from the upper.

Causes of Death after Colotomy.

These will vary somewhat according to the presence of obstruction or no. 1. Exhaustion, especially if the operation has been deferred too long. 2. Toxic conditions due to the continued distension of the intestines, and the resulting absorption by the patient of poisonous material. 3. Extravasation of fæces and burrowing suppuration. This is especially liable to happen in very fat patients, in whom there is a difficulty in getting the colon up into the wound, especially if the bowel must be opened at once. As the fæces pump out under high pressure,

* Mr. Lockwood (*Brit. Med. Journ.*, 1882, vol. ii. p. 574) explains the abnormalities of the large intestine by the fact that, during its development, it is very mobile; the cæcum occupying first the umbilical, then the left, next the right hypochondrium, and, finally, the right iliac region, abnormalities may follow its arrest at any part of its course.

a sufficiently* free opening should in these cases be made into the bowel after this has been secured as carefully as possible.

4. Peritonitis. This may be due to the operation directly, or more indirectly from fæcal or purulent retro-peritonæal extravasation, or from septicæmia. Often it is not due to the operation, but to the want of it at an earlier stage. Thus, the distended bowel may have given way just above the obstruction; often it is that weak spot the cæcum which is found perforated after the stress of distension.†

5. Septic cellulitis, erysipelas, &c. These are not always preventable in an exhausted patient where it has been necessary to open the bowel at once.

6. Vomiting. This has been noticed in a few cases to occur obstinately and fatally after colotomy. Mr. Couper (*Brit. Med. Journ.*, 1869, vol. ii. p. 557) thinks that it is not an infrequent cause of death, and suspects that traction on the bowel, its proximity to the stomach, and the fact that both receive nerves from the solar plexus will account for this.

7. Broncho-pneumonia, pleuritic effusion, especially if the wound has become septic in an exhausted patient.

INGUINAL, ILIAC, OR ANTERIOR COLOTOMY.

Of late years this has replaced the lumbar operation in nearly all cases which call for colotomy (*vide supra*, p. 117).

The advantages of the iliac operation are chiefly—(i.) It is easier. Thus, (a) the patient, being on his back, takes the anæsthetic better than when rolled on his side; (β) in a stout patient, especially, the soft parts are easier to divide, and the resulting wound less deep and more readily dealt with than one in the loin; (γ) the bowel is more easily reached, and with less disturbance of deep-lying soft parts; (δ) there is no risk of opening small intestine, or of failing through abnormality of the colon. (ii.) The peritonæum being opened of set purpose, the surgeon can examine the site and extent of the disease. (iii.) The shallower wound makes it much easier to draw out the intestine, and make a satisfactory angle and spur, or to perform colectomy. (iv.) The position of the anus renders it more easily accessible for the needful attention.

If the above advantages are considered separately, I think there is no doubt that the first (and this is the most important one) is correct. Where the colon is distended, the lumbar operation is an easy one; but where the bowel is flaccid and lies deeply far away in a fat patient, the

* Not needlessly large, for fear of troublesome prolapsus later.

† The following reasons have been given in explanation of this well-known fact—viz., the proneness of the cæcum to give way under the stress of distension, and even when at some distance from the obstruction. Dr. Coupland and Mr. Morris (*Brit. Med. Journ.*, 1878) attribute it to the *cul-de-sac* nature of this part of the intestine; its fixity and dependent position; its being the place where two currents meet—viz., from the ileum and, in case of regurgitation, from the colon; and the pressure to which it is subjected between the iliacus and the abdominal muscles. Mr. Lockwood (*St. Bart. Hosp. Reports*, vol. xix. p. 26) thinks that the explanation lies rather in the peculiarity of structure of the cæcum, as it contains a very large amount of lymphoid tissue, and as its walls are not strengthened equally with other parts of the large intestine by encircling bands.

operation, in spite of the aids given at p. 120, is one of the most difficult in all surgery. I am speaking now from an experience of twenty-nine cases of my own and a large number which I have seen performed by my colleagues. Iliac colotomy, with the thinner soft parts, the deliberate opening of the peritonæum, and the more accessible colon, is a far easier and simpler operation. The second advantage claimed—that an iliac colotomy enables the surgeon, by opening the peritonæal cavity, to examine into the site and extent of the disease—will be found an important one, for the surgeon can decide for or against the possibility of the removal of the growth at a second operation, or he may be able to bring the growth outside the abdomen and excise it some days later when the patient has recovered from the intestinal obstruction. The third advantage is an important one in those cases where a deep wound loaded with fat makes it very difficult to bring up and anchor a lumbar colon satisfactorily. On the fourth point, on which much stress has been laid—that an artificial anus in front is placed more satisfactorily for the patient's needs than one in the lumbar region—there is something to be said on both sides. A patient with an artificial anus in front can clean this, adjust the pad, and wash out the bowel below far more comfortably. If the motions have been allowed to become constipated, and, in order to get relief, assistance must be given from without—a very real difficulty sometimes, and one requiring considerable time and attention on the patient's part—this can be done very much more easily with an anus in the iliac region. On the other hand, the passage of flatus or the effluvium of a suddenly escaped motion will be greater annoyances with an anus placed in front. And it is obvious that in some conditions of daily life a lumbar opening may be very superior to one in front. Thus, at one time I watched for seven years a case of lumbar colotomy which I performed in a young married woman, aged 20.

The disadvantages of iliac colotomy next require attention.

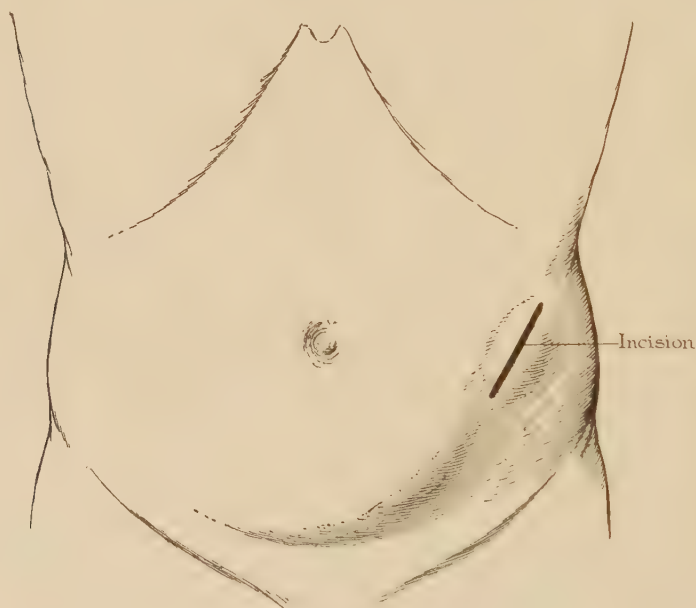
1. There is the opening of the peritonæum. While I readily allow that antiseptic details, faithfully followed, have gone far to remove the old dread of the peritonæum, the risk of peritonitis still remains considerable, especially in late cases when the bowel is distended, friable, and easily torn in attempting to draw it into the wound; fæcal extravasation is then difficult to guard against. Moreover, in these late cases, the patient's general health is often depressed from fæcal intoxication and starvation, and his power of repair very poor. The peritonæum, too, frequently contains serous or sanguineous fluid, and is in a very receptive state for any infection, especially when the bowel is distended.

2. A much larger amount of prolapsus follows this than the lumbar operation. Of this there can be no doubt whatever. It must be so, on anatomical grounds, viz., the far greater mobility of the sigmoid colon, the greater laxity of the soft parts in the groin as compared with those in the loin, where we have the lumbar fascia, psoas, and kidney. These points, together with the fact that in walking, standing, and sitting*

* "A pad and bandage which is satisfactorily adjusted with the patient standing will require readjustment with the patient sitting. . . . I have been consulted by several subjects of iliac colotomy on this point, and found their grievance to be a real one" (Bryant, *Lancet*, 1881, vol. ii. p. 1215).

the small intestines must necessarily tend to push upon and protrude an inguinal artificial anus, all explain why prolapsus after inguinal is so much more marked than after lumbar colotomy. This result, if the prolapsus be a large one, causes great discomfort to the patient, the projecting, moist, readily bleeding mass in the groin interfering much with cleanliness and locomotion. While the precautions given later will serve to diminish the amount of prolapsus, this will always give more trouble here than in the lumbar region: a tendency to large prolapsus there is quite exceptional; with iliac colotomy it is common. On the other hand, an artificial anus, as opposed to a fæcal fistula, is much more easily secured after an iliac colotomy.

FIG. 52.



Site of incision for inguinal colotomy.

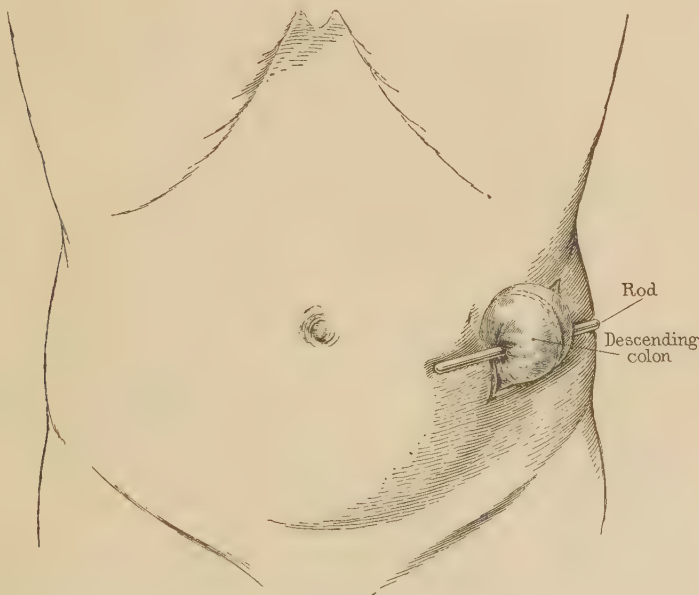
3. Another objection to iliac colotomy, and one which I thought would be found a real one—that for disease high up in the rectum, or of the sigmoid flexure, an iliac opening would be placed too near the seat of mischief—does not seem to have been verified. Rectal cancer, for which iliac colotomy is usually performed, very rarely extends high enough up to give any trouble. If, on performing the iliac operation, the surgeon comes down on a growth in the sigmoid, he must resect it, or make an opening above it, or perform a lumbar colotomy.

Operation.

The parts having been duly cleansed, an incision 2 or 2½ inches long is made 2 inches above and parallel with the outer part of Poupart's ligament and the anterior superior spine and with its centre above the line joining this bony prominence and the umbilicus. There are three points here of the greatest importance from their bearing on the chief drawback of this operation, prolapsus. Mr. Cripps ("Complications

arising in Inguinal Colotomy," *Brit. Med. Journ.*, Oct. 19, 1895) finds that by making his opening in the abdominal wall somewhat higher than in his earlier cases, there is much less tendency to protrusion. He now makes his "incision nearly as high as the level of the umbilicus, so that the wall of the lower part of the abdomen, where the pressure is greatest, is left intact." Another point to be insisted on is that, wherever the opening is made, it should be as small as possible. The freer the incision, the weaker the abdominal wall—already naturally weak here—and the more certain is a large prolapsus to follow. In an ordinary case of iliac colotomy for rectal cancer, the operator should endeavour to find the sigmoid with an opening admitting one finger to

FIG. 53.



Inguinal colotomy.

explore deeply, if need be, as far as the pelvic brim, and hook up the sigmoid. Lastly, it is an advantage to use the "gridiron" or valvular incision similar to that which McBurney introduced for the removal of the appendix. The risk of prolapse is much diminished, and the control obtained over the artificial anus is greater. Carwardine (*Pract.*, vol. 74, 1905, p. 179) cuts across the fibres of the external oblique aponeurosis, making his skin incision also in the direction of the muscular fibres of the internal oblique and transversalis. He states that he thus avoids the contraction of the orifice that is liable to occur if the tendinous fibres are merely separated. When the incision is placed as high as advised above, the tendinous fibres of the external oblique are not seen. More œdema of the prolapsed loop is apt to occur when muscular separation is adopted instead of division of the muscular fibres, but this soon passes off. The layers of the abdominal wall having been separated, and all hæmorrhage arrested, the

peritonæum is then raised, and slit up with scissors for about two-thirds of the wound already existing. It is not necessary to sew the parietal peritonæum to the skin and this step increases the tendency to prolapse. The intestine rapidly adheres to the muscular wound. The sigmoid or the omentum or small intestine may be seen in the wound. If either of the two latter present (and the omentum may do so very persistently), they are returned, and the colon sought for with the finger. It is usually close at hand, and may be recognised by the scybala which it contains, or by its appendices epiploicæ and longitudinal muscular bands, which are not always obvious however. In difficult cases the bowel will be found by searching in the iliac fossa, the finger being passed along the parietal peritonæum from without inwards, until the sigmoid is encountered attached to the posterior wall; this is the best method. Failing this, the descending colon may be traced down from the kidney. It is well to remember that anterior colotomy is not always the easy operation, as regards finding the bowel, that it is represented to be. Mr. Cripps speaks (*loc. supra cit.*) of occasionally having had great difficulty in finding the bowel.

In one case, after a long search, he was unable to find the bowel; the nurse being directed to give an injection of water, the finger near the brim of the pelvis then felt a piece of intestine, which had before been overlooked, becoming distended, and the sigmoid, which was lying almost over in the right iliac region, was thus detected. In these cases of difficulty Mr. Cripps thinks that the colon will almost invariably be found nearer the middle line of the abdomen than where the operator has been searching.

In a case of Mr. Cooper's, reported by Dr. Pennington, of Chicago (*Journ. Amer. Med. Assoc.*, 1893, vol. ii. p. 773), the operator having failed to find the sigmoid, water was injected into the rectum, and was noticed to pass into the right iliac fossa. The opening in the left side being closed, an incision was made in the right inguinal region, where the gut—presumably the misplaced sigmoid—was readily found. The patient made a good recovery.

In some cases, the wound may have to be enlarged by prolonging the separation of the two deep muscles inward, opening the rectus sheath, and drawing the rectus inwards, then the large intestine may be traced upwards from the rectum, if necessary.

The bowel being found, a loop of it is drawn up into the wound. In the next step the operator should carefully follow Mr. Cripps (*Brit. Med. Journ.*, 1889, vol. i. p. 771). To avoid the prolapse which is certain to occur if loose folds of the sigmoid remain immediately above the opening, this surgeon gently draws out as much loose bowel as will readily come, passing it in again at the lower angle as it is drawn out from above. In this way, after an amount varying from one to several inches has been passed through the fingers, no more will come. As soon as the descending colon is found in this way to be nearly taut, a pair of dressing-forceps is pushed through the meso-sigmoid about a quarter of an inch from its attachment to the bowel, and a straight piece of sterilised gum elastic catheter No. 10 or 12 caught in the forceps and drawn through; a glass rod or a vulcanite one suitably pointed at one end may also be used. This is then supported outside the abdominal wall at either end by antiseptic gauze. If the meso-sigmoid is thick and laden with fat, a nick may be made over the forceps and rod, any vessel being, of course, avoided. The angles of the wound may be closed by salmon-gut sutures if necessary. The colon is covered with aseptic green protective to prevent adhesion to the dressings.

The wound is dressed with gauze or small sterile pads arranged all around the bowel so that the latter is in a kind of box and is not liable to be damaged by the firm pressure that must be maintained to prevent protrusion of more bowel* through the wound. This danger can be avoided by applying a broad band of strapping firmly all round the body but outside the dressings (Davies-Colley). The bowel may be opened by a transverse incision on the third day.† No anæsthetic need be given; if the patient is nervous, a 10 per cent. solution of cocaine may be applied. A few days later all the bowel that projects above the skin is cut away with scissors, Spencer Wells's forceps being applied to each bleeding point.

When the artificial anus is only required as a temporary measure a longitudinal incision is made into the bowel, for this leads to less gaping and is easier to close.

Some surgeons support the loop of bowel outside the abdomen by joining the edges of the skin through a rent made in the mesentery; this provides a splendid spur, for the two openings into the bowel ultimately left are separated by a bridge of skin.

In some cases, the loop of the intestine cannot be drawn out of the wound and fixed by means of a rod passing through the mesentery, the latter being too short. In most of these cases, however, the bowel can be brought well up into the wound and fixed by means of numerous sutures passed through the sero muscular coats of the intestine and the margins of the parietal wound.

All sutures should be removed by the tenth day, or earlier if any redness is present.

When the projecting loop has been pared down, as advised above, two openings will be seen separated by an efficient spur. Through the lower of these the rectum can be washed out, and the removal of any fæces lying above the disease facilitated. Gradually, usually in about a month, the patients will begin to acquire some control over their artificial opening, but it will not be till several months after the operation that they can be said to become comfortable in this respect, and acquire satisfactory control over, and management of, their artificial anus. And for the rest of their life discharge of blood and slime will occur from the anus with frequency, varying according to the rate of growth of the original disease. This must be met by astringent injections and suppositories. Diarrhœa must be treated by strict attention to diet, and by astringents; escape of offensive flatus or fæces from the artificial anus (which is more perceptible to the patient when the opening is made in front) may be met by the use of charcoal, a teaspoonful being given twice a day, or the following may be taken twice a day in a capsule or cachet, viz., betol, salol, salicylate of bismuth, of each gr. v. (Mr. C. Heath, *Brit. Med. Journ.*, vol. i. 1892, p. 1243).

Where obstruction is present, the bowels much distended, and the sigmoid requires immediate opening, anterior colotomy may still be employed, but additional care must be taken in handling the intestines

* This is especially needed during the first few days. Mr. Cripps insists on the nurse sitting by the bedside to apply pressure if vomiting occurs.

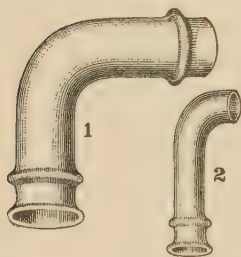
† Vomiting and distension of the abdomen are indications for opening the bowel earlier; it is safe to do so if necessary after 24 hours.

and in preventing any escape of fæcal fluid or gas into the peritonæal cavity.

The following methods may be adopted :

(a) Extra pains may be taken to suture the bowel accurately to the edges of the wound, and the line of suture should be protected by careful gauze packing. The gaseous contents of the bowel may then be let out through a small cannula passed obliquely through the wall of the intestine ; this may afford temporary relief in some cases until adhesions have formed.

FIG. 54.



No. 1 is for the large, No. 2 for the small, intestine.

The lower end is tied in, the upper receives the drainage-tube. (Paul.)

(b) Or better, some form of enterostomy tube may be inserted to conduct the thin and very virulent fæcal accumulation to a receptacle well away from the wound. A portion of the bowel is emptied and gently clamped, and the tube introduced without contaminating the wound if possible.

A Paul's tube may be tied in (Fig. 54). The objection which has been raised to the method, namely, that sloughing and loosening of the tube take place too rapidly, may be met by making use of a purse-string suture to fix the tube, and by taking care not to tie the ligature tighter than is absolutely necessary. See also Enterostomy.

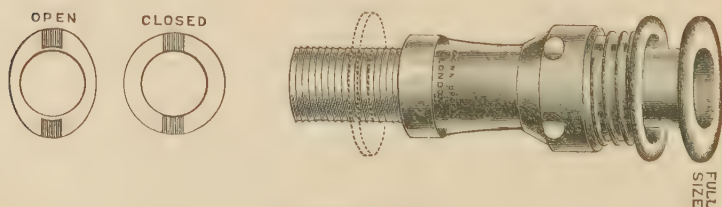
Carwardine's (*loc. cit.*, *vide* Fig. 55) enterostomy tube may be used ; this is more expensive but also more secure than a Paul's tube, and it does not become detached so soon.

A much simpler, lighter and smaller metal tube is employed by the writer (*vide* Fig. 56). The thin rubber tubing having been previously secured to the outer end of the tubes the inner extremity is secured in the bowel by a purse-string suture.

Greig Smith's method of fixing a long rubber tube in the intestine is very simple and nearly always practicable.

Lilienthal's (*Ann. of Surg.*, Jan. 1906) visceral evacuator prevents

FIG. 55.



Carwardine's tube.

leakage but is somewhat complicated, large and rigid for use in colotomy. It is likely to be of more value for the temporary drainage of distended intestine during an operation for the relief of acute obstruction by a removable cause like a band.

I would strongly impress on my younger readers the need of careful attention to the following points when dealing with chronic obstruction low down in the large intestine by inguinal colotomy.

First, the sigmoid is difficult to find, owing to the tendency of the small intestine, much distended, to crowd out of the wound. It is very easy, during the necessary handling of such intestine, to make small tears in the peritonæal coat. In meeting the above difficulty the operator, if he cannot find the sigmoid quickly, should enlarge the wound and pack away the small intestine with flat sponges attached to forceps. The second point is the great care needed in suturing a distended sigmoid when it is brought to the lips of the wound, it being now very easy to perforate the mucous coat, and thus cause an escape of flatus or fæces before the peritonæal sac is shut off.

Madelung's Modification of Colotomy.—This has been largely used, both in the lumbar and inguinal operation, abroad. In this country it has not found favour. It consists in drawing out the bowel sufficiently, packing the wound with small sponges attached to silk, while the loop of intestine (which, if full, should be emptied as far as possible) is squeezed around with tampons of iodoform gauze. The intestine being clamped, or held by the fingers of assistants, is next cut across. The clamp is then removed from the lower end, which is emptied, cleansed, and closed by careful suturing, viz., one continuous, and then others by Lembert's method, causing efficient inversion of the sutured extremity. This end is then dropped back into the peritonæal cavity. The upper end is now fixed in the wound, or is drained by tying a glass tube in it to which india-rubber is attached, by the method of Mr. Paul (Fig. 54) (*Brit. Med. Journ.*, vol. ii. 1891, p. 118).

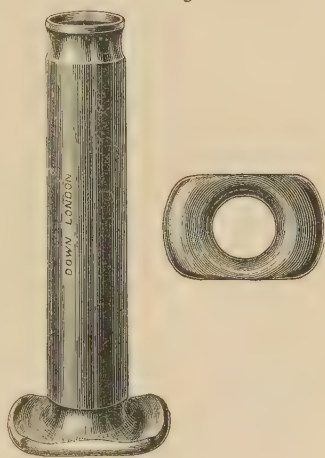
The above method has never been much used in this country, for the following reasons:—

1. The great advantage which it claims, of preventing the passage of fæces into the lower part of the bowel, may be secured by much simpler means, viz., pulling out the bowel sufficiently to get an efficient spur, and cutting away the intestine afterwards.

2. It has inherent grave objections:—

(a) It has happened again and again that when the mesentery is long the sigmoid has, unknown to the operator, become twisted, and thus, when it is drawn up into the wound, the upper instead of the lower end may be closed and returned. In such a case fæcal extravasation through the sutures into the peritonæal cavity must occur. Mr. H. Allingham states (*Brit. Med. Journ.*, 1891, vol. ii. p. 337) that in seven of his inguinal colotomies the gut must have been thus "twisted," as fæces came away through the lower of the two openings. He states that he knows of a fatal termination from this cause in several cases in which Madelung's operation had been adopted. Mr. Cripps (*ibid.*, p. 447) has met with two cases in which what he believed to be the lower end of the bowel eventually proved to be the upper. Dr. Landon, of Göttingen

FIG. 56.



Enterostomy tube.

(*Centr. f. Chir.*, Bd. xxx., 1891), has explained the above fact by a necropsy.

In two cases of inguinal colotomy in the Göttingen clinic, where the usual practice is to divide the gut and to stitch the two open ends in the wound, it was noticed that fæces always discharged from the lower and not from the upper opening, although at the operation the lower part of the intestine had been traced towards the bladder, and the upper in the reverse direction. In one of these cases, which terminated fatally, the necropsy showed that the sigmoid, which was very long and freely movable, passed upwards and outwards as far as the splenic flexure of the colon, and then curved downwards and towards the middle line, reaching the rectum after a long and tortuous course.

(b) The lower end of the bowel, whatever precautions are taken before the operation, will contain some fæces above the site of the cancer: if the lower end of the bowel be sutured, these fæces must cause irritation and increased discharge; if they be scybalous, and the bowel above the stricture thinned, as it often is, they may bring about fatal ulceration. (c) Closing the lower end prevents any attempt at washing out the bowel by syringing through from the colotomy opening to the anus or *vice versâ*, and so diminishing the constant tendency to sanious mucous discharge, which, if left to collect above the cancer, hastens its growth and promotes its sloughing. (d) It adds to the severity of an operation in patients who, from their present and in view of their future, need careful handling. This is true of inguinal colotomies when the bowel is empty. If it be distended, severing the bowel adds greatly to the difficulties of what is now a trying operation, and increases the risks of contamination of the peritonæum.

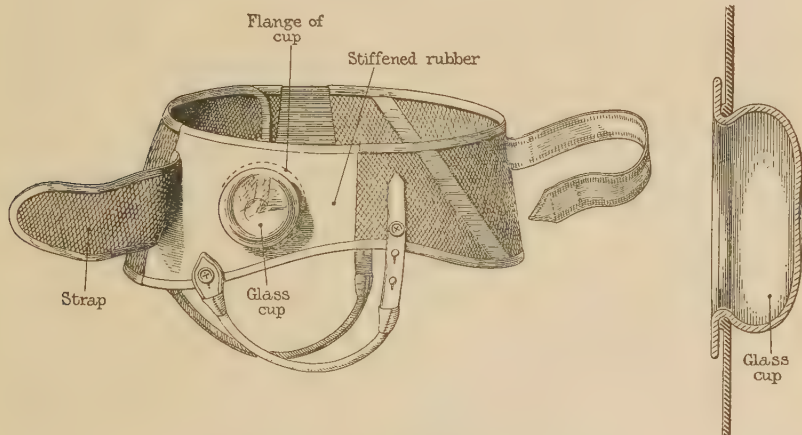
This modification of Madelung's is, I think, only justifiable when colotomy is performed previously to removal of part of the rectum: even under these circumstances I think it may be harmful, by preventing the washing out of the intervening bowel which may add so much to the comfort of the patient. Any surgeon about to divide the bowel should make certain of the lower end by asking an assistant to pass from below, if possible, a small œsophagus-bougie.

Hartwell (*Ann. of Surg.*, vol. 42, 1905, p. 273), in performing colotomy as a preliminary to excision of the rectum brings the sigmoid into the wound through a gridiron incision at the level of the left anterior superior spine; he then divides the clamped bowel across at a distance of about 12 inches from the anus. The distal end is then fixed at the lower angle of the wound. The proximal end is protected by gauze and drawn upwards and inwards between the rectus muscle and its anterior sheath and secured in a median vertical incision near the middle line. Care is taken not to damage the vessels of the meso-sigmoid during this manœuvre; the mesentery is only slit enough to allow the intestine to come into the median wound without tension. Hartwell claims that this method gives the patient more control than any other. It seems to me unnecessarily severe and moreover it is not practicable without gravely increasing the risk where the sigmoid is distended and friable in obstructive cases.

If the artificial anus contract unduly, it must be dilated with laminaria tents and the patient's finger. Mr. Cripps has introduced a spring dilator which is self-retaining, and which can be worn for four or five hours daily. That this complication is one to be watched for is

plain from this passage in Mr. Cripps's experience (*Brit. Med. Journ.*, vol. ii. 1895, p. 966): "This is not an uncommon sequence, and, if allowed, will destroy the whole advantage of the operation. Too small an opening means a constant dribbling of fæcal matter, the motions never getting freely and completely away. These contractions do not occur where the original opening has been made of proper size, and where all the wound has healed by first intention, but occur where the angles of the wound have failed primarily to unite, and where the granulations gradually become converted into firm contractile tissue. If the angles have not united properly, the contraction will begin about the third week; and if at this time a little spring dilator be introduced and worn for a few hours daily for a month, the tendency to undue contraction will be obviated. If this precaution has been neglected, or be impracticable, the opening can readily be made the right size by passing the finger into the bowel, and then completely cutting

FIG. 57.



Colotomy belt. (Pengelley, Bailey & Co.)

through all the contractile tissue up to each angle, the depth of the cut exposing the wall of the bowel. The bowel is now freed a little on either side of the incision, and a curved needle and silk thread is passed through its edge, and through the tissues and skin at the apex of the reopened wound. This suture is tied, bringing the gut well up to the angle. A couple of additional sutures may be necessary at the sides."

Colotomy appliances.—Until the patient has gained some control over the artificial anus, or has learnt how to manage it, a dressing of lint smeared with some simple ointment and changed as often as may be necessary is the best thing for the patient. Later some form of belt or spring truss may be fitted. A belt gives more general support and keeps in position better than a spring truss. Rubber belts sag and rarely fit; plugs if hollow collapse and turn sideways, if solid (vulcanite) they irritate so much that the patient discards them; if made of rubber they soon perish. The apparatus illustrated in the figure is the best of many that I have tried. It consists essentially of a strong glass cup, held in position by a firm and accurately fitting belt. Fæces

rarely leak from the cup, which is air-tight when in position. For prolapsus a suitable receptacle can be made.

Complications and Difficulties in Inguinal Colotomy.—Many of those given at p. 124 are common to the inguinal and lumbar operations. Some more specially belonging to the former operation will be given here.

1. Difficulty in finding the bowel. This has been fully entered into at p. 130. It is well to remember that the claim so strongly put forward, that the inguinal is an operation of no difficulty as compared with the lumbar, is not always correct. 2. Absence or shortness of mesentery. I will here quote Mr. Cripps (*Brit. Med. Journ.*, vol. ii. 1895, p. 966): "This is perhaps the most unfortunate and dangerous complication that can be met with, and to this cause, with one exception, I owe all my fatal cases. In the great majority of cases the mesentery of the sigmoid flexure is amply sufficient to allow of the bowel being well drawn up in the wound, and safely fixed without tension; but in 3 or 4 per cent. this is not so, for there is absolutely no mesentery, the bowel being bound firmly back against the posterior parietes. This is either due to congenital deficiency, or to malignant disease behind the colon fixing it firmly. The question to be considered is as to what should be done after the surgeon has opened the abdomen and met with one of these cases. I am confident, from my unfortunate experience, that any endeavour to invert the skin and forcibly drag it down to the bowel by the sutures is a fatal mistake. The sutures will certainly cut through, leaving an open peritonæal cavity." The surgeon should avoid mistaking the fixed descending colon for the sigmoid by tracing the bowel down into the pelvis, where he may discover a pendulous and mobile loop of sigmoid which should be brought into the wound and opened if the obstruction be below it. If the mesentery is really too short, Carwardine's advice may be followed, and the mesentery of the central part of the selected loop tied and divided; the loop can then be retained in the wound by bringing the edges of the skin together through the mesenteric gap. Gangrene of the loop may occur if the mesentery be subjected to much tension, or if its vessels be divided too freely. I would suggest another means of meeting this difficulty, which I adopted in the only case that I have met with in which the sigmoid was absolutely tied down in the iliac fossa, apparently from a congenital absence of the mesentery. The lower part of the incision being closed, its upper extremity was prolonged backwards into the lumbar region, where, at the junction of the descending and sigmoid colons, the bowel was sufficiently mobile to be brought up into the wound. This course will, I believe, always be found feasible. It is preferable to performing a right colotomy, as it saves two wounds, and rolling the patient over on to a recently made wound, while it removes an objection inseparable from a right-sided colotomy, that a more or less extensive tract of bowel is left below the opening, containing feces which it is not easy to get rid of. Moreover the more fluid and irritating nature of the feces make a right lumbar colotomy very troublesome. 3. Prolapsus. The frequency of this after the operation has been explained at p. 127. It may be met (*a*) by making the wound as high up as possible (p. 129); (*b*) drawing down the intestine till the upper end is tight (Cripps), and then bringing it out through as small and valvular an opening as possible;

(c) closing this opening round the bowel, and the bowel to the edges of the wound, as securely as possible, whether a rod (p. 130) has been used or no; (d) keeping the patient at rest until the parts have had full time to consolidate; (e) treating assiduously any such causes as constipation, coughing, straining in micturition, &c.; (f) trying the effect, as early as may be, of a light spring truss and pad. The two following complications may occur during vomiting or coughing. 4. Small intestine or omentum may escape between the piece of sigmoid which has been drawn out and the edges of the wound. This accident may be known by the urgent vomiting, pain, collapse, and soakage of serum into the dressings. These should of course be removed at once, the small intestine cleansed and returned, and the wound made safe by additional sutures. This accident is most likely to occur when a large wound has been made, an insufficient number of sutures used, or sufficient support has not been provided by means of a belt of strapping (p. 131). Where omentum protrudes—a much rarer complication—it may be left, as it will all shrivel away gradually, but additional sutures should be inserted at once. 5. A rarer accident, of which Mr. Cripps has published an instance (*Brit. Med. Journ.*, vol. ii. 1895, p. 967), is where the bowel tears away from its attachments and falls back into the peritonæal cavity. This happened on the seventh day during a violent fit of coughing.

“The released bowel discharged a considerable motion into the peritonæal cavity. Fortunately, I saw the case about an hour after the accident. The fæcal matter was thoroughly washed out from the abdomen, and the detached bowel restitched. The patient recovered.”*

6. Strangulation of small intestine between the attached sigmoid and the parietes. An instance of this very rare accident will be found recorded by Mr. Cripps (*loc. supra cit.*, p. 967).

A patient on whom inguinal colotomy had been performed was about to leave the hospital when he was seized with symptoms of acute obstruction, the pain being referred to the colotomy opening. After vomiting three or four times the patient said he felt something slip in his inside; the vomiting ceased, and the pain suddenly left him. A few days after, feeling quite well, he was discharged from the hospital, and was re-admitted ten days afterwards in a dying condition. The necropsy showed that a loop of small intestine had slipped down into a canal, about an inch long, between the attached portion of the gut and the reflection of the parietal peritonæum, near the anterior superior spine. From this canal the intestine must have released itself at the first attack. Mr. Cripps adds that prompt abdominal section would have saved this patient.

Causes of Death after Anterior Colotomy.—Many of these will be the same as those given in the account of the lumbar operation (p. 125), and others, more peculiar to the anterior operation, have been so fully given in the pages just preceding that there is no need to repeat them here.

* Mr. C. Heath's remarks on this or a similar case (*Brit. Med. Journ.*, vol. i. 1892, p. 1243) are worth the attention of anyone inclined to think lightly of such an accident because the patient recovered. “Of course we hear of one case that did recover, but we do not hear of the ninety-and-nine cases which did not.” The writer remembers a similar case, which terminated fatally although the peritonæum was cleansed within a couple of hours.

RIGHT INGUINAL COLOTOMY.

MAKING AN ARTIFICIAL ANUS IN THE CÆCUM.

This operation is but rarely made use of. One objection to it is that, owing to the proximity of the small intestines, the intestinal contents are likely to be more liquid, and thus to cause more trouble afterwards. It may be resorted to under such conditions as the following :

(1) In cases of acute following upon a chronic obstruction of the ascending colon or hepatic flexure, it may be employed as a temporary measure to save the patient from his urgent danger; later the growth may be removed and still later the colostomy may be closed (Carwardine, *Pract.* 1905, vol. 74, p. 179). If during an exploration in the middle line the growth in such a case is found to be irremovable, it is better to perform ileo-sigmoidostomy and thus avoid a permanent and very troublesome fæcal fistula.

(2) In certain cases of volvulus of the cæcum, in which the bowel is replaced, yet greatly distended and damaged, a temporary cæcostomy may be also wisely done, and this may serve to fix the viscus and thus prevent recurrence.

(3) As a temporary measure for granting complete rest or allowing efficient irrigation of the large intestine, in some cases of colitis or dysentery.

It is possible that the future may prove appendicostomy to be preferable to cæcostomy for some or all the above three conditions.

A permanent cæcostomy is very objectionable on account of the frequent and irritating discharges, which often induce very troublesome inflammation and even ulceration of the skin of the abdomen.

In some of the above instances the primary incision will be over the cæcum, and, personally, when the surgeon has been exploring the site of an obstruction through an incision near the middle line, and determines to open the cæcum, I think it would be wise to do this through a second incision in the right iliac region, as I consider it risky to anchor intestine in the middle line.

Sir F. Treves (*Lancet*, vol. ii. 1887, p. 853) published a very successful case, in which exploration in the middle line detected a stricture at the termination of the descending colon. As the cæcum was enormously distended, its peritonæal coat having given way at several spots, he brought the cæcum into the wound in the linea alba, bringing all the most damaged part of the wound, which was united round it. A puncture of the cæcum through one of the rents allowed an immense amount of gas to escape. Fortunately no fæces were seen. The hole in the bowel was clamped, and the wound dressed with iodoform. When the bowel was opened on the fifth day a large quantity of fæcal matter escaped. Six months later the patient was in excellent health.

On the other hand, the case of Mr. Cripps, which I quoted at p. 137, shows how very small a space between anchored bowel and the parietes may be sufficient to bring about a fatal strangulation.

Operation.

In some cases the surgeon may experience considerable difficulty in getting the cæcum satisfactorily into the wound from congenital or acquired adhesions to the iliac fossa.

The cæcum is exposed through the "gridiron" incision used for removing the appendix. A part of the anterior wall or lower pole of the cæcum is then fixed to the parietal peritonæum by a circle of continuous catgut suture. If immediate drainage be imperative one of the enterostomy tubes described on p. 132 is then introduced. When the operation is performed for colitis, there is no need to open the bowel at once, and an incision may be made into the cæcum after the lapse of 24 or 48 hours, when peritonæal adhesions will have formed. Curl (*Ann. of Surg.*, April, 1906, p. 543) employs this method for the treatment of dysentery by irrigation. He prevents closure of the muscular wound by anchoring the cæcum by silk sutures to the four corners formed where the oblique muscles decussate.

Gibson (*Boston Med. and Surg. Journ.*, Sept. 25, 1902) recommends the application of Kader's method of gastrostomy for making a valvular opening into the cæcum for the treatment of various forms of chronic colitis by irrigation. It is claimed that little or no leakage occurs after this operation, and that the fistula soon closes on withdrawing the catheter.

MAKING AN ARTIFICIAL ANUS IN THE TRANSVERSE COLON.

This may be performed as a temporary measure when a removable growth of the splenic flexure, or descending colon is discovered during an exploratory laparotomy for acute following upon chronic intestinal obstruction. Under these circumstances it is far safer to perform a temporary colostomy than to be too ambitious and to attempt a primary resection. When the intestines have been emptied of their virulent contents, and the patient has recovered from his immediate danger of death, the growth may be resected, an end to end anastomosis performed, and the colostomy closed or allowed to close later.

When the cause of the obstruction is found to be a removable growth of the transverse colon, it may be possible to bring the loop of bowel containing the growth outside the abdomen and to fix it there by means of a glass rod through the meso-colon or by sutures. The surgeon having protected the abdominal cavity by careful gauze packing, may then be content to merely relieve the obstruction by tying an enterostomy tube in the proximal limb of the loop. Later he can resect the growth and close the artificial anus, or the growth may be immediately removed and Paul's tubes tied in the two limbs of the loop. The contiguous peritonæal coats of the two stumps of intestine may be sutured together to pave the way for the subsequent closure of the artificial anus (Bidwell, *Brit. Med. Journ.*, vol. i. 1902, p. 322).

An artificial anus in the transverse colon is, from its high position, more manageable than a sigmoid colostomy, and from the more solid character of the fæces, it is greatly superior to a right lumbar or cæcal fistula.

Mr. Bidwell (*loc. supra cit.*) in an able article maintains that "colostomy should never be performed for any growth that is situated above the middle of the sigmoid flexure, and that an artificial anus made in such a case should be only a temporary one left after the removal of the growth." For such cases ileo-sigmoidostomy or some other suitable form of ileo-colostomy is far preferable for a surgeon

skilled in abdominal surgery. In skilled hands this operation is only a little more dangerous than colotomy, even when the obstruction is complete, but for those less experienced and without the advantages of skilled assistance, colotomy remains the safest if not the most brilliantly successful treatment.

The disadvantages, and constant annoyances of a colotomy are so great and so well known, that a patient may reasonably be advised to run some additional risk in order to avoid them; thus after an anastomosis a man may be able to lead an active and profitable life for a considerable time without becoming unpleasant to his neighbours, which is a rare thing after colotomy.

APPENDICOSTOMY (WEIR'S OPERATION).

This operation was first described and practised by Dr. Weir, of New York (*New York Med. Record*, Aug. 9, 1902). He was performing a cæcostomy for chronic colitis when the appendix presented itself just at the right moment, and Dr. Weir saw and took immediate advantage of his opportunity. Recently the important contributions of Mr. Keetley (*Brit. Med. Journ.*, vol. ii. 1905, p. 863) and Sir W. H. Bennett (*Lancet*, vol. i. 1906, p. 419) have brought the operation into more general notice, and many surgeons are now giving it a trial. Much of what follows is derived from the excellent and suggestive articles written by the authors named above. The following are the chief conditions and objects for which the operation has been recommended.

Indications.

(1) For the introduction of irrigating or medicating fluids into the cæcum and colon in certain cases of chronic colitis and amæbic dysentery.

(2) For the local treatment of the lower ileum in some cases of enterica.

(3) For the introduction of fluids into the cæcum in a few cases of obstinate chronic constipation.

(4) For the administration of foods and fluids in a few cases of carcinoma of the stomach, &c.

(5) For temporary drainage of the cæcum in some cases of intestinal obstruction, also for temporary drainage and fixation in some cases of ileo-cæcal intussusception and volvulus of the cæcum.

(6) For the relief of intestinal distension in cases of peritonitis, &c.

These indications will be considered more fully after the description of the operation.

Operation.

(a) The appendix is sought through the usual incision employed for its removal, the aponeurotic and muscular fibres of the abdominal wall being separated, and the peritonæum divided sufficiently to admit two fingers. Adhesions and other difficulties may cause delay and may even make the operation a serious one, so that it is not to be lightly undertaken under gas and oxygen or local anæsthesia as recommended by some writers.

The appendix is drawn out through the wound so that the cæcum is brought into contact with the abdominal wall, and two fine catgut sutures are passed through the sero-muscular coats of the appendix and the parietal peritonæum, and tied so as to fix the appendix, and

close the peritonæal wound without compressing the vessels of the meso-appendix.

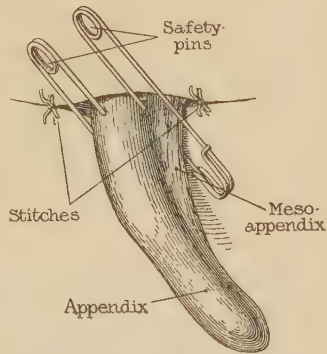
Care must be taken not to damage these vessels or subject them to much tension. Curl (*Ann. of Surg.*, April, 1906, p. 545) mentions three cases in which the appendix sloughed even after careful handling. Sometimes the mesentery is so short that it has to be tied and divided. When there is no need for immediately opening the appendix, Sir William Bennett retains it in position by means of two sterilised safety pins passed through the sero-muscular coats of the appendix, and closing the abdominal wound beneath the pins. After twenty-four hours, when adhesions have formed, the appendix may be cut across a quarter of an inch from the level of the skin, and the margins of the opening sutured to the edges of the skin; these sutures serve to prevent undue retraction of the appendix during healing. If the parietal wound be carefully closed the appendix may be opened at once, if necessary, and a soft rubber catheter with a fine flexible stilette can then be inserted for the introduction of fluids.

(b) During an exploratory laparotomy, the surgeon may decide to use the appendix as a temporary spout for the escape of fæces or gas, as recommended by Mr. Keetley (*Brit. Med. Journ.*, vol. ii. 1905, p. 863). A stab wound can then be carefully made in the abdominal wall over the appendix, which can be drawn out and fixed in the manner described above. If necessary the lumen can be stretched by means of fine-bladed forceps, or by bougies. When the fistula has served its purpose it may be closed most easily by the simple method described by Mr. Maunsell. He dissects away the mucous lining of the stump and leaves a short muscular tube, which heals in a few days; thus a laparotomy is avoided.

Appendicostomy is usually a very simple operation, but it cannot always be performed, for the appendix may have been already removed, or be so tied down with adhesions, or so diseased and contracted at its base, that it cannot be safely used. Mr. Spencer (*Lancet*, March 12, 1904) found the appendix so adherent that he had to perform cæcostomy in one case. In one hundred autopsies at St. George's Hospital, the appendix was a fibrous cord in two bodies, and in two others the lumen near the base would only admit a small bristle; but an appendicostomy could probably have been performed in the remaining ninety-six.

(1) **Colitis and Dysentery.**—As an alternative for cæcostomy and right lumbar colostomy in the treatment of cases of colitis suitable for surgical treatment, appendicostomy has the following important advantages:—(1) The fistula does not allow any leakage of fæces, because it is controlled by a sphincter at its base, and more or less protected by a

FIG. 58.



Appendicostomy (after Sir William Bennett, *Lancet*). The safety-pins pass through the peritonæal and muscular coats only.

valve of mucous membrane on its cæcal aspect; thus the very troublesome irritation of the skin, which is often associated with the older operation, is entirely prevented. (2) The saving of the fluid contents of the cæcum for more complete absorption in the large intestine may be a gain, especially in very feeble subjects; thus Goddard maintains that about 10 per cent. of the fat, for instance, is absorbed in the large intestine (*Lancet*, March 25, 1905, p. 795). (3) The appendicular fistula is very easily closed, whereas the difficulties of closing an opening in the cæcum are well known.

Gibson's valvular cæcostomy also generally guards against leakage, and it often closes easily on removing the tube; it is probably the best procedure to adopt when it is found to be impossible to perform an appendicostomy.

Whether the above gains compensate for the lack of rest, and the irritation of the inflamed colon by the fæces, is an open question, only to be decided by time and experience.

The place of appendicostomy and irrigation in the treatment of colitis is as yet uncertain. Mr. Keetley (*loc. supra cit.*) gives the following results of nine reported cases. No death had occurred as a result of the operation, but in one fatal case the operation was only performed when the patient was *in extremis*. None of the patients were any worse for the operation. Seven cases were entirely successful, and the issue of the last case remained to be seen.

Since then Gray has reported two cases (*Lancet*, vol. i. 1906, p. 596).

Case i. Male, æt. 30, had severe ulcerative colitis which had resisted all treatment by the mouth and rectum; his condition was desperate, but appendicostomy was performed, and the colon washed out with various antiseptic solutions. Improvement occurred for three weeks, but a week later the patient died, and advanced ulceration of the colon and *lower end of the ileum* was found at the autopsy.

Case ii. Female, æt. 22, had diarrhoea, and passed extensive casts; her symptoms were annoying rather than serious. Weak solutions of argyrol were introduced through the appendix for three weeks, when the symptoms subsided, and the fistula was allowed to close, which it did rapidly. A tendency to relapse was noticed later.

Morley Willis (*Lancet*, vol. i. 1906, p. 1180) reports a case of mucous colitis in a female, æt. 32. The disease had lasted for two years; the colon was irrigated by soap and water, introduced through the appendix; two or three pints were used at a time. Much improvement had occurred in a month.

Stretton (*Lancet*, vol. i. 1906, p. 1833) exhibited one case and read notes of another before the Kidderminster Medical Society. In the last case the patient was able to irrigate her colon with comfort and efficiency, greatly to the relief of her chronic colitis.

Nearly all the cases recorded had not been under observation long enough to enable us to arrive at any conclusion as to the ultimate results. Cases have been claimed as cures after a few weeks or months. It must be remembered that these patients must remain well for several years before the results can be claimed to be entirely successful. Every physician knows that relapses are frequent in colitis. Hale White and Golding Bird (*Clin. Soc. Trans.*, 1902) publish a case of a relapse of mucous colitis after two years' relief from right lumbar colotomy. It is extremely probable that appendicostomy will be found to be of very little use in severe cases of ulcerative colitis

and severe cases of dysentery with deep ulceration. It is likely that the operation will be found to be of real value in milder cases of colitis, but which have not reacted to medical treatment by the mouth and rectum, but care must be taken to keep the fistula open until all signs of the disease have disappeared.

Curl concludes "from observation of eleven cases of dysentery, that in intermediate cases in which there is still a reasonable amount of strength, but where treatment is not controlling the dysentery, the operation of cæcostomy with irrigation of the colon with quinine solution is indicated. Cæcostomy is preferred to appendicostomy because of less sloughing and an earlier closure of the fistula. A rapid improvement usually follows the beginning of the irrigation, but convalescence is slow, and at times difficulty is experienced in closing the fistulæ. The after-treatment—irrigation, &c.—is tedious, and the patients are offensive cases to have in a ward. All in all it is the lesser of two evils, but in my opinion it saves lives in selected cases." (*Ann. of Surg.*, 1906, vol. xliii. p. 543.)

Curl does not state in how many of these cases he performed appendicostomy—presumably a minority only; it is surprising to read that the fistula closed more rapidly in the cæcostomy cases. Quinine solution was the irrigating fluid used; in eight out of eleven cases partial or complete recovery occurred; in two, as demonstrated by autopsy, there was extensive and deep ulceration, and also nephritis. One was so weak that cæcostomy was performed under cocaine anæsthesia, and death occurred the following day.

Many kinds of irrigating fluids have been recommended, such as: normal saline solution, starch, infusion of marshmallow, oil, lime water. Various astringents, such as nitrate of silver solution, ipecacuanha in suspension, glyco-thymolin, argyrol, liquid paraffin, 2 oz. daily (Ewart); quinine solution for dysenteric cases (Curl).

Dr. Dawburn (*Ann. of Surg.*, vol. 37, p. 613) used potassium permanganate $\frac{1}{10000}$ solution, alternating every six hours with the same amount of normal saline; about ten pints of the solutions, at a temperature of 120° Fahr., being used at a time. The case was one of dysentery, and was much improved by the treatment, but the cure was not complete when Dr. Dawburn presented the case only a few weeks after the operation.

Dr. Ewart (*Lancet*, vol. i. p. 1511, 1906) has given a helpful account of his method of irrigation. A No. 8 india-rubber catheter is introduced by means of a blunt-ended, very pliable copper stilette; it is apt to coil in the cæcum unless care be taken to pass it upwards as well as backwards. A good sized rectal tube is then passed to conduct the outflow into a suitable receptacle by the side of the bed. Tubing and funnel are fixed to the catheter, and both the afferent and efferent tubes have clips attached, and also a piece of glass tubing inserted. By elevation and depression of the funnel the rate of the injection can be regulated, and the rate of the outflow and amount of distension of the colon (if any is desirable) can be controlled by means of the clips. Dr. Ewart has used as much as twenty pints in one irrigation.

It is probable that the hopeful results obtained depend more upon the careful lavage than upon any particular kind of chemical solution used. The patient should not complain of pain during the irrigation unless the outflow be obstructed, or too much pressure be employed. The patient should be kept supine unless the fluid does not run well, when he may be turned on to his left side to overcome any possible obstruction at the hepatic flexure of the colon,

(2) **Enterica.**—It has been suggested by Dr. Ewart that appendicostomy may be useful for gaining access to the ileum through the ileo-cæcal valve for the application of direct local treatment to the diseased intestine.

Mr. Keetley (*Lancet*, 1906, vol. i. p. 1023), has also suggested that the toxic and irritating contents of the lower ileum may be drained off by a tube passed through the appendix and the ileo-cæcal valve and retained in position. Box and Eccles have pointed out that much of the ulceration of the lower ileum may be due to the stasis of infected fæces above the ileo-cæcal sphincter.

Ewart (*loc. supra cit.*) has been able to pass a catheter into the ileum with ease in a case of chronic colitis; he had already gained experience on the cadaver. It is noteworthy that the neck of the appendix has a fairly constant relation to the orifice of the ileum, however much the tip of the former may vary in its position. Dr. Ewart and his assistants used a soft rubber catheter, containing a very pliable copper wire stilette, which is bent into a loop at the end for safety. The catheter is bent at an angle of 110 degrees. About two and a half inches from its extremity it is passed inwards, downwards and backwards. The catheter may be known to have entered the ileum by the greater length (up to nine inches) introduced, by the subjective sensations of the patient, and Dr. Ewart had skiagrams taken showing the stilette to have reached the brim of the pelvis on the left side.

Systematic Lavage of the Lower Ileum.—Ewart and Aylen state that they were able to irrigate about a foot or two of the small intestine. After a preliminary cleansing irrigation they passed a No. 2 gum elastic catheter into the ileum, and a No. 6 instrument is passed into the cæcum, where it acts as a draw-off for the fluid returning from the ileum. Medicating fluids may thus be applied to the ulcerated intestine low down.

So far no case of typhoid has been recorded in which this mode of treatment has been employed, and it does not seem to me to be a hopeful procedure for the following reasons.

It is not free of danger; the diseased intestine may be perforated by the tube or hæmorrhage induced; without special experience it is not easy to pass the tube into the ileum, and the latter cannot be emptied by any system of irrigation yet invented; it is not even claimed that more than a foot or two can be washed out. It may also be remembered that the bacillus of typhoid fever is not limited to the intestinal contents, but flourishes in the walls of the bowel and in the mesenteric glands. Mr. Keetley believes that appendicostomy would be of value in typhoid fever chiefly by providing a means for keeping "the large intestine well and frequently washed clear of fæces polluted with discharges from the ulcerations, and to substitute for these discharges abundance of water or neutral saline solution."

Mr. Keetley is more in favour of enterostomy and makes the following remarks, which seem to me to be too optimistic. "With a laparotomy the ileum could be opened a yard above the ileo-cæcal valve. Two principal techniques are available: (1) resembling that of a sigmoid colotomy, and (2) resembling that of a Witzel's gastrostomy. With the former the last yard of the ilium and the whole of the large intestine could be placed at rest, no fæces passing through, but only the warm weak saline or silver solutions prescribed by the physician. With the latter much, if not all, the fæces would still pass on to the rectum and natural anus. Medication would be easy, but rest would not be secured. The first technique would be the quicker to do, while the anatomical result of the second technique would be simpler to undo when the patient had recovered. But resection of a portion of small intestine for the purpose of closing such an enterostomy opening as this which we are discussing should, in competent hands, be a very safe procedure, because (a) it would be of *small* intestine, not large, and (b) there would be no embarrassing adhesions such as often complicate fæcal fistulæ which have been caused by tubercle, by appendicitis, or by other diseases attended by peritonitis."

The surgical treatment of typhoid fever is certainly worthy of consideration, for if surgery can be shown to do anything to lessen the

mortality (about 10—15 per cent.), and diminish the dangerous and troublesome complications of this disease, it will render welcome aid to the physician as well as to the patient. It will not be easy to determine the indications and the time for surgical interference in any given case.

(3) **Chronic Constipation.**—Mr. Murray (*Brit. Med. Journ.*, vol. i. 1905, p. 1299) first suggested appendicostomy as a treatment of intrac-table cases of chronic constipation. Since then Mr. Keetley (*Brit. Med. Journ.*, vol. ii. 1905, p. 863) has tried the operation.

A girl of 15 suffered from severe chronic constipation. At the time of the operation the bowels had not been opened for 3 weeks, and the patient was vomiting. Median laparotomy disclosed a pendulous transverse colon reaching to the pubis, but there was no other abnormality. The appendix was brought out through a button-hole incision, and the median incision closed; the appendix then slipped back and had to be brought out again and fixed. Four days later the superfluous part of the appendix and its mesentery were removed without causing any pain. The ligature which secured the vessels of the meso-appendix was also used to retain a soft tube inserted in the fistula. A saline injection was given, and later some $\frac{3}{4}$ ij of mist. alba, and a pint of saline. These were very efficacious, and lately an injection of water alone procures a daily evacuation. The patient herself passes a No. 10 catheter. No leakage occurs, and the patient's health has much improved.

It remains to be seen whether this treatment may be proved by more experience to be of real and permanent use in the treatment of those rare cases of constipation which are not amenable to medical treatment. It is certainly worthy of trial in preference to such drastic measures as ileo-sigmoidostomy and extensive colectomy.

(4) **Ileo-Cæcal Intussusception.**—Mr. Keetley (*loc. supra cit.*) performed appendicostomy after reducing an intussusception of the lower end of the ileum, cæcum and appendix in an infant aged one year and ten months. The reduction was performed through an incision in the right rectus, and then the appendix $6\frac{1}{2}$ inches long was pulled out through a button-hole incision made over it, and the end was cut off and the stump fixed. $\frac{3}{4}$ vij of normal saline were injected at 6 p.m., and the bowels were moved at 7 p.m. and 9.45 p.m. The stump of the appendix was removed 15 days later, but its site was fixed to the wound.

The operation was performed for several reasons: for the relief of gaseous distension, the administration of fluids which acted partly as aperients, and fixation of the bowel with a view of preventing recurrence.

The appendix would probably be of even more service in cases of primary cæcal intussusception.

(5) **Volvulus of the Cæcum.**—The following interesting case recorded by Mr. Maunsell is probably the first in which appendicostomy has been tried for volvulus, and it is certainly encouraging.

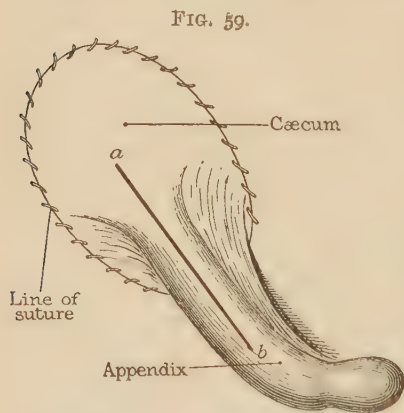
Female, æt. 77, subject to chronic constipation. Volvulus of the cæcum was discovered in the pelvis on exploration; the greatly distended cæcum was deflated and then withdrawn and uncoiled, and the puncture closed. The appendix was brought out through a stab wound at the outer border of the right rectus. Some vessels of the meso-appendix had to be tied; the appendix was fixed by two sutures and its distal end amputated. The fistula was dilated with sinus forceps and a gum elastic catheter tied and left in for 4 days. From the first gas and some fluid feces escaped from the opening and the abdomen kept flat. Later the mucous membrane lining of the stump was excised and the fistula closed in a

few days. The patient did very well although some suppuration occurred in the exploratory wound, probably due to soiling during deflation.

(6) **Intestinal Obstruction.**—In 1894, Keetley (*Brit. Med. Journ.*, Nov. 17, 1894, p. 1155) first suggested the use of the appendix as a spout for the relief of intestinal obstruction, instead of cæcal colostomy.

In 1905, the same surgeon was the first to put this operation to the test, and the following account is taken from Mr. Keetley's paper (*Lancet*, vol. i. 1906, p. 1023).

"In the past winter I have had the opportunity of using the appendix as a spout for giving egress to fæces in a case in which it would otherwise have been necessary to perform a cæcal colostomy. In a case under the care of Dr. James Crombie* mentioned by me in a former paper appendicostomy was performed partly with this object. In all other published cases of appendicostomy the operation has been performed wholly for the purpose of admitting the injection of fluids into the large intestine. The question was, Could the appendix be sufficiently dilated? I felt almost sure it could because I have seen it so dilated by pus, by large concretions, and by intussusception of the appendix.



Appendicæstomy (after Keetley, *Lancet*). The cæcum and appendix are secured to the abdominal wall, ready for opening extra-peritoneally.

by sutures in layers. The wall was very thin, the patient being emaciated, with very little muscle and no fat. I intended, if I found the appendix not sufficiently dilatable, to cut its mucous membrane with a bistoury or hernia knife in such a manner that if the appendix split open it would give way in the line A, B. The result would, of course, be the performance of what might be termed an 'appendicæstomy'—i.e., an opening partly in the appendix and partly in the cæcum, but altogether outside the stitched-off peritoneal cavity, though overlapped by skin and fascia. However, the next day I had no difficulty in stretching this appendix to the size of a small rectal tube, and for three months the fæces passed through it, the intestinal obstruction, which was due to a large malignant growth obstructing the transverse colon, being completely relieved. The patient had carcinoma of the stomach with some infection of the general peritonæum (malignant nodules were seen on the peritonæum and adhesions were felt matting the parts together above, and to the left of, the umbilicus and beneath the left rib cartilages). Within 48

* *Brit. Med. Journ.*, vol. ii. 1905, p. 863.

hours the greatly distended abdomen had emptied itself through the appendix, assisted by warm water enemata. More recently some fæces have passed per rectum. This patient's abdomen was explored last summer and the carcinoma of the stomach was found but was too advanced for removal. A friend of mine performed a jejunostomy by Mayo Robson's method but as the patient could still take food by the mouth she allowed the jejunostomy opening to close. I reopened it on the morning of the day on which I performed the appendicostomy, and she was, to a great extent, nourished by what passed between the jejunostomy and the appendicostomy. Still she took some food by the mouth, both solid and liquid, and efforts were made to keep the large intestine properly supplied with water either by the rectum or through the appendix. The nurse found it most convenient to keep both the appendicostomy and the jejunostomy tubes permanently *in situ*, as the patient complained when they were replaced. Some cutaneous irritation complicated the jejunostomy opening but none the appendicostomy. There was no excoriation whatever, such as is apt to occur with ordinary cæcal fistulæ.

"This patient was, and remained, under Dr. J. A. Shaw-Mackenzie's trypsin treatment. Having regard to the advanced stage of the case she held her own in a marvellous way and she was free from pain except what was attributable to distension by ascites. Death came, from exhaustion, three and a half months after the appendicostomy. (I have mentioned that the peritonæum was found to be affected at the time of operation. In February I drew off 150 ounces of ascitic fluid.)

"This is, so far as I know, the first case in which the appendix has been continuously used as a spout through which to *evacuate fæces*. It was for this purpose that I suggested that the appendix should be used at a debate on cæcal colotomy at the Medical Society of London 11 years ago."*

It is probable that appendicostomy will replace cæcostomy for the relief of at least some cases of intestinal obstruction due to stricture of the colon. The growth may be removed later and the appendicular fistula easily closed when the channel has been firmly re-established. The appendix should be carefully but thoroughly dilated in order to provide free drainage. It must be remembered however that with only a fistula out of the cæcum, fæces passing over the line of suture may interfere with proper union. An artificial anus is more satisfactory in this respect although far more troublesome to close. Ileo-sigmoidostomy is more satisfactory except that it is more risky for most surgeons. For cases of irremovable growth of the colon, some form of ileo-colostomy is far preferable if the surgeon is experienced and the patient's condition not too serious. Mr. Keetley's case shows how very useful appendicostomy may be even in late cases; but it may not always be so easy to find and especially to dilate the appendix as in this case.

I have recently performed appendicostomy for the relief of intestinal obstruction due to irremovable growth of the ascending colon. There were miliary growths in the peritonæum, and some larger secondary masses in the pelvis, so that ileo-sigmoidostomy was not practicable, even if the patient's condition had been better. In right lumbar colostomy the opening would be too near the growth, and appendicostomy was preferred to cæcostomy, because it could be performed more quickly and without any risk of infecting the exploratory wound near the middle line, which was covered with a sealed dressing. A large amount of fæces escaped from the appendix when it was opened after 12 hours, and the patient was greatly relieved. The dilated appendix did not give a free enough vent however, for the old lady complained of colicky pains occasionally, and she died after three weeks from a perforation of a stercoral ulcer in the lower end of the ileum, although the fistula had seemed to act well. The patient was in a very bad condition when she

* *The Lancet*, November 17, 1894, p. 1155.

was admitted, and it is quite possible that the ileum was ulcerated then and that a perforation would have occurred even if a freer opening had been made into the cæcum. I think that this case illustrates a real danger, however.

In cases of severe intestinal distension embarrassing the breathing and leading to paralytic distension of the intestine if unrelieved, appendicostomy may prove to be a simple way of giving great relief; especially is this likely to be so in some cases of general suppurative peritonitis, and some cases of intestinal obstruction after removal of the cause.

CHAPTER IV.

OPERATIONS ON THE KIDNEY AND URETER.

NEPHROTOMY—NEPHRO-LITHOTOMY—NEPHRECTOMY— NEPHRORRAPHY—OPERATIONS ON THE URETER.

BEFORE undertaking an operation upon any of the urinary organs the surgeon should, of course, ascertain the state of the general health of the patient, and he should also endeavour to gain all the information he can about the condition and functional capacity of each one of the urinary organs. It is especially important before operating upon one kidney to know the state and working capacity of the other. By means of more comprehensive examinations the surgeon may hope to make more accurate diagnoses, and to avoid useless and incomplete operations. Armed with a full knowledge of the value of the other kidney, the surgeon can more easily decide upon the extent of the operative treatment permissible in a given case, as well as the nature of the prognosis that may be given. On the other hand, valuable time must not be wasted on useless investigations, and vexatious and dangerous ones must not be undertaken unless they are likely to lead to valuable conclusions. In addition to the valuable information to be obtained from the history, symptoms, physical signs, chemical, microscopical, and bacteriological examinations of the urine, the catheter and the sound, there are other means which may provide even more useful knowledge in some cases. *The cystoscope, the segregator, skiagraphy, the estimation of the urea in the separated urines, and cryoscopy* may complete the diagnosis made by the older methods, which are sometimes quite sufficient if well considered.

The surgeon must decide which of these comparatively new methods of investigation to use and rely upon in any given case. Some of them require special skill, and the value of some of them is as yet uncertain. It is well to remember that we cannot afford to reject reliable information obtained from any source, new or old, and that correct conclusions are generally arrived at from a careful consideration of all the available evidence without attaching undue weight to any one sign or symptom. It may be wise, therefore, to make some remarks here upon the possible value and place of these most recent aids to diagnosis.

A. **The cystoscope.**—Used by a surgeon who is accustomed to it, and capable of interpreting what he sees, as well as conscious of its limitations, the cystoscope renders invaluable aid in the diagnosis of the various diseases of the bladder, and a full consideration of the instrument will be found in the section of this book referring to these diseases,

It may also be very useful in helping the surgeon to decide in cases of difficulty of diagnosis between renal and vesical disease; thus the source of a hæmaturia of doubtful origin may be proved to be a villous tumour near one ureter. It may also help us to decide which kidney is affected, for a skilful observer may see blood or pus exuding from one ureter or he may observe an ulcerated, retracted or dilated ureteral orifice, indicative of the side of the renal disease. Cystoscopic ureteral catheterisation besides being a very difficult, tedious procedure, not free of danger even in practised hands, is no longer necessary for the separation of the urines for diagnostic purposes, for the segregator provides us with a far simpler and safer means of attaining this desirable object. Further, the ureteral catheter may give very misleading results, for the instrument may get blocked, or its orifice be obstructed by mucous membrane, and it is quite common for the ureter to bleed a little from slight injury to the mucous membrane inflicted during the introduction of the instrument; this may easily lead to error. The danger of infecting a healthy kidney from a diseased bladder has been referred to. Even Kelly's far safer and comparatively simple direct method of catheterising the female ureter is not so easy as segregation, and the former disturbs the patient and the bladder more.

B. The Value of the X-Rays in the Diagnosis of Urinary Diseases.—The X-rays are capable of giving invaluable aid in the diagnosis of urinary diseases, but for reliable results a skilled radiographer, who has devoted much time and care to this method of investigation, is essential. He should also have a knowledge of anatomy and clinical experience to guide him in his work and guard him against mistakes. The evidence obtained by this means is not to be taken alone, but should be carefully weighed in conjunction with other facts, for by itself it may be misleading like all other solitary signs. Mr. Shenton (*Lancet*, vol. ii. 1906, p. 719) in an able article upon this subject rightly lays great stress upon the importance of screen examinations, and points out that the value of photographs is comparatively small, and to be taken as records of the objects seen upon the screen, and for future reference.

In comparing the two methods Mr. Shenton makes the following important remarks:—

“‘The smaller the diaphragm the better the skiagram,’ would be a true maxim if it were borne in mind that the actual image does not become smaller, and therefore the diaphragm must be sufficiently large to include the object examined. We have no method of reducing the size of our image as in photography, for the X-rays cannot be refracted, reflected, or influenced in any such way. Now it would be very laborious and well-nigh impossible to take a quantity of little skiagrams about one and a half inches in diameter all over the urinary areas, and it is, therefore, to the screen that we must turn for assistance. In a screen examination it is possible to examine the patient in a series of small areas and in this lies one of the superiorities of screening over photography. Moreover, the amount of movement constantly present in the abdomen, whatever precautions are taken, such as holding the breath, fixing the kidney with compressors, &c., makes photography in small areas often of little use, whereas the slight movement upon the screen is a positive help in the detection of a foreign body.

“Upon discerning the slightest suspicion of a foreign body the patient

is told to take a deep breath. This is done for two reasons: first, a moving body is often easier to detect than one remaining stationary; and secondly, the relative movements of this object and surrounding organs bear an important relation to one another. For example, if, as is usually possible, one edge or part of the kidney is observable, note whether the movement of this and the foreign body are coincident. If they move as one the inference is in favour of the object being a stone in the kidney, and if the relative movements do not coincide it is extremely probable that the contrary is the case. Contract the diaphragm upon this suspicious object and try to make out its outline. Renal stones have often such characteristic shapes that this may be valuable evidence. Systematic search is made in this manner in renal, ureteric, and bladder regions, being careful to look up as high as the last two ribs, and while in this position make the patient breathe deeply, for I have several times in this manner driven a stone from its lurking place behind a rib. The kidney is a more movable organ than is usually described and normally moves appreciably with respiration. When examining over the bladder region pressure on the screen should be made as this much improves the screen picture. In this region the sacrum must be remembered, but its extreme symmetry prevents it being mistaken for calculus material; also, in the event of finding calculus in this region remember the possibility of its being in the lower ends of the ureters. I have found calculi in both ureters at the same time and from the comparison of their appearances have been able to give their composition; in one case this was oxalate of lime in the right and phosphatic material in the left."

"When examining a photograph, it should be generally understood that if a skiagram, particularly of the lumbar regions, possesses great pictorial beauty, a clear spine with a few well-defined and clear-cut ribs, it is usually inadequate so far as diagnostic value is concerned. Pale stones, such as phosphatic calculi, and little stones will not appear, and to show these it is essential to get a dull grey image which, from a pictorial point of view, is unattractive."

"In speaking of the screen in the diagnosis of urinary calculus I am not putting forward an untried theory, but one which a very large series of cases has proved to be sound and practical. It has reduced the inaccuracies of this branch of radiography to a minimum, and where failures do occur they are usually traceable to inability to carry out the method I have described completely. In the work I have done for St. Peter's Hospital and which, owing to the kindness of Mr. S. Allen, I have been able to check as to accuracy, there has not been an X-ray report that has been proved incorrect since this system of strict screen examination was substituted for the former photographic method."

An incomplete X-ray examination is of no great value, and may be very misleading. Before undertaking a nephro-lithotomy for instance, it is not enough to know that there is a stone in one kidney without ascertaining the condition of the corresponding ureter and that of the opposite kidney and its duct. To gain this knowledge a complete examination of both sides is necessary in addition to an estimation of the urea in the separated urines. Failure to take this precaution may lead to an unwise or incomplete operation.

When a stone is discovered in the bladder, it is more than likely

that there is another at its source in one kidney or in the corresponding ureter, therefore a screen examination of these organs should be made. An elderly man was greatly relieved by the removal of a stone from his bladder, but within a year another vesical calculus had to be removed, and soon afterwards the patient died from uræmia and suppurative nephritis; then it was discovered that both kidneys contained several stones, although the patient had never complained of any renal symptoms.

It can be safely stated that with proper precautions radiography is free of danger to the patient, and on this account as well as that of accuracy, it compares very favourably with other methods of investigation, such as cystoscopy, segregation, and especially ureteral catheterisation; it is also more universally applicable, for cystitis, stricture, or enlargement of the prostate may limit the application of one or more of these methods.

That the evidence obtained from radiography has become more and more accurate in the last few years must be the experience of every surgeon who is fortunate enough to secure the services of an experienced and capable radiographer, and the following remarks from an excellent paper by Dr. Leonard, of Philadelphia (*Lancet*, vol. i. 1905, p. 1632) are well worth quoting upon this point:—

"This claim of accuracy for the negative or exclusion diagnosis is borne out by the statistics of the cases examined by myself. There have been but four cases in which calculi have been found on operation or passed in the series of 330 cases examined since I claimed equal accuracy for the negative and positive diagnosis, and the negative diagnosis has been confirmed by operation forty-seven times. There have been six other cases in which the surgeon failed to find a small calculus detected by the Röntgen-ray or in which only a mass of cretaceous substance was found in the pelvis of the kidney. It is probable that half the errors were due to defective operating, a delay after the examination sufficient for the calculus to pass, or its escape during the operation."

"... The total amount of error in both the positive and negative diagnosis is less than 3 per cent. of the 330 cases examined. This is a percentage of error that compares very favourably with any other method, or all other methods of diagnosis, including exploratory nephrotomy."

"The effect of the greater accuracy in the diagnosis of calculous conditions by this method upon surgical procedures has been to render a complete operation with the minimum of surgical interference impossible without the comprehensive diagnosis which it affords. It has also decreased the necessity for operation by furnishing valuable indications for a conservative expectant line of treatment that is fully justified by results already obtained. The value and wisdom of such a course of treatment in selected cases of ureteral lithiasis has been demonstrated by the passage and recovery of calculi in 26 cases without operation. In addition to rendering the operation complete this method has localised the operative intervention, making it unnecessary to explore the other kidney or the ureter when only the kidney is the seat of calculous disease. The value peculiar to this method of diagnosis and the accuracy claimed for it can only be secured by a

technique capable of making an accurate negative as well as positive diagnosis. Such technique cannot be obtained without careful study and must be fortified by a clinical experience that renders the operator capable of translating the diagnosis accurately from a radiographic plate in which he recognises the features essential to the establishment of the diagnosis. Infallibility is not claimed for this method but a greater amount of accuracy has been established than is possible by other methods. Even such accuracy cannot be expected unless the operator has acquired a technique and clinical experience that warrant a belief in his accuracy. The great difficulty is that the surgeon expects equal accuracy from every operator and condemns the method because his clinical experience has brought him in contact with an operator who is unfitted to employ it accurately."

"The early period at which this method of diagnosis can determine the presence or absence of lithiasis is of the utmost importance, for when the symptoms have become sufficiently obvious to make it possible to recognise the condition pathological changes are often far enough advanced seriously to affect the functional efficiency of the kidney."

Very small calculi may not be discovered by means of the Röntgen-rays, and therefore a negative result is not always final. Uratic stones are also difficult to see, but calculi formed of urates or uric acid only are very rare, some phosphate or oxalate being practically always present in sufficient quantity to give a shadow. Henry Morris (*Lancet*, vol. ii. 1906, p. 141) has shown that xanthin and cystin calculi are discoverable by means of the X-rays. Quite small oxalate and phosphatic stones are opaque and easily shown.

Creteaceous mesenteric glands, phleboliths within the pelvic veins, atheromatous plates in the walls of the arteries, ossifying pelvic ligaments and tendons, and scybala in the colon have all been mistaken for calculi, but with greater knowledge and experience these mistakes are becoming quite rare, but the possibility of their occurrence should be remembered. In cases of doubt it is well to have two examinations, and it is always wise to give a purgative on the day before an examination is made, so that fecal concretions may not mislead the radiographer.

Hurry Fenwick (*Brit. Med. Journ.*, June 17, 1905) passes an opaque ureteric bougie in order to avoid such errors; this procedure is very difficult in the male, and not devoid of danger in either sex, but with these reservations it may be found useful in some cases.

The X-rays may give some information in other renal diseases; sometimes the kidney may be seen to be enlarged, for instance, or unduly fixed, suggesting a growth.

Negative radiographic results should not be allowed to prevent or defer renal explorations which are strongly indicated by other evidence; this is especially true of unilateral hæmaturia of unknown cause; delay in a case of this kind may allow a renal growth to become irremovable.

C. The segregator or separator (Luys).—This may render valuable aid by enabling us to collect the urines from the two ureters separately.

(a) Blood or pus may come from one side only indicating the side of the disease.

(b) The percentage of the urea coming from each kidney may be estimated, and thus the diseased organ may be determined and roughly

the comparative value of the two kidneys, supposing both to be diseased, as proved by the discharge of morbid urine from both ureters. The freezing points of the separated urines may also be obtained.

(c) Similarly the amount of sugar coming from each kidney in the Phloridzin test may be determined, and also the amount, time of onset, and duration of the elimination of chromogen in the methylene blue test. Urine of different degrees of colour may flow from the two tubes.

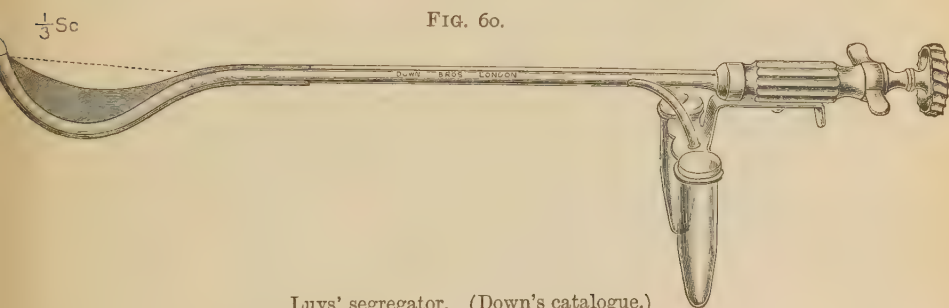
(d) It may enable the surgeon to distinguish between renal and other enlargements as shown by Bickersteth (*vide infra*).

(e) It may help us to find out whether unilateral, primary or idiopathic nephritis really ever occurs.

It must be remembered, however, that a certain amount of skill and a knowledge of anatomy are required in the use of the instrument, which may be very misleading if carelessly handled; thus a case has been recorded in which urine came from both tubes although the patient only possessed one kidney; it is easy to understand that a slight relaxation of pressure on the bladder base may allow urine to pass the india-rubber diaphragm from one side to the other. The instrument is not reliable unless the bladder has been seen to be free of disease by cystoscopy, for, as pointed out by Fenwick (*Med. Annual*, 1905, p. 36), villous growth, carcinoma, encysted stone or inflamed pouch may each add morbid products to the urine of one side only, and this would lead to serious error. It cannot be relied upon in cases of enlarged prostate owing to the irregularity of the bladder base, and it should not be used in cases of contracted bladder due to carcinoma or late tuberculosis, and it cannot be used in cases of urethral stricture until the stricture has been dilated. Luys first described his valuable invention in October, 1901, and demonstrated its use before the International Medical Congress at Madrid in 1903. Bickersteth introduced the instrument into England and wrote a valuable paper on the subject with references and an account of cases (*Lancet*, March 26, 1904). The instrument is best sterilised by boiling, which does not spoil the india-rubber if not continued too long. The genitalia are thoroughly cleansed and anæsthetised by the injection of a 5 per cent. solution of cocaine into the urethra and "milking" it backwards into the deep urethra in the male, or by placing some cotton wool soaked in the cocaine solution between the labia in the female. A general anæsthetic is very rarely necessary and is not an advantage. Before making these preparations the patient should drink about a pint of water, tea or Contrexeville water. Some contrivance must be made for sitting the patient up and providing him with a back rest during the separation; this attitude is essential for complete success. Mr. Bickersteth's account of the introduction and use of the instrument is so good that I make use of it verbatim.

"The first step of the actual procedure is to pass a catheter and to draw off and to set on one side the specimen of the "mixed urines" thus obtained. Next, the bladder is washed out and upon the carefulness and thoroughness with which this is done much will depend. It is essential that the bladder should be thoroughly clean and if each of the last two or three "washings" is collected in a clean urine glass and the fluid is seen to come back perfectly clear the surgeon may feel

satisfied that so far he has done his work well. Then about two ounces of fluid are injected into the bladder and all is now ready for introducing the "separator." As a rule the instrument slides easily and smoothly into the female bladder without any difficulty at all; in the male a little difficulty may at first be found. The curves of Dr. Luys's separator, designed solely with the object of making the instrument fit closely and naturally against the floor and neck of the bladder—and which at first sight may perhaps strike an observer as peculiar—are, after all, only a little shorter and sharper than those of the French "bougies de Béniqué," in which very similar curves are selected as being most suitable for the ordinary instruments used in the treatment of stricture. These curves, when once the surgeon is used to them, do not cause any difficulty in getting the point of the separator well into the bladder, but it must be admitted that at and beyond this point when it is required to pass the whole curved part of the instrument right on into the bladder itself a little difficulty may certainly be met with until by practice the operator has learnt how to do it. As soon

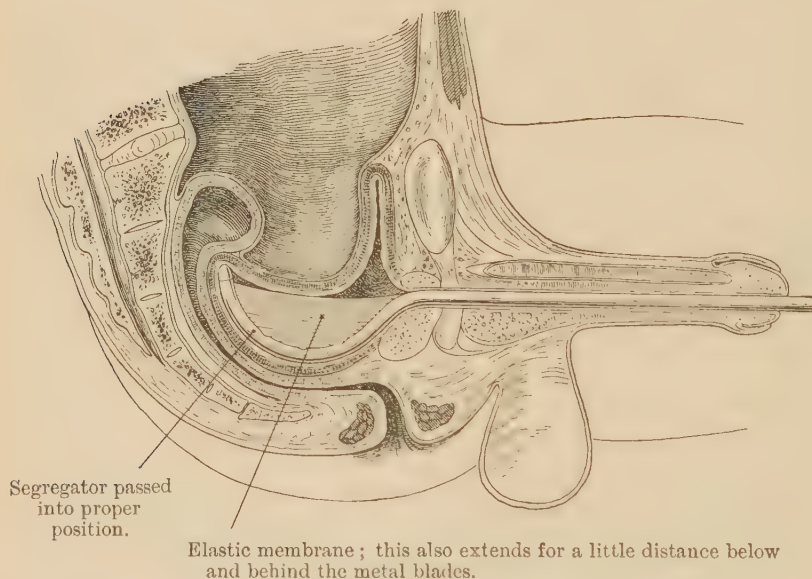


Luys' segregator. (Down's catalogue.)

as the curved part has been passed fairly into the bladder, the back rest is raised and the patient is placed in the sitting position. Then by turning the screw at the end of the handle the rubber partition is raised and the injected fluid is allowed to run off by the two catheter tubes, the ends of which have been closed by our fingers during the foregoing manipulations. This not only shows that the catheter eyes have not become blocked by urethral mucous, &c., but by filling the catheters themselves it starts what seems to be a syphon action and allows the urine to flow off from the bladder as fast as it enters it from the ureters. In order that the curve of the instrument may press with sufficient firmness upon the floor of the bladder to make the partition water-tight and the "separation" trustworthy only one thing more is now necessary, the surgeon must raise the handle a little, and while doing this at the same time draw the whole instrument gently forwards towards him; it must always be remembered that the most gentle pressure suffices for this and that no force at all is either necessary or permissible. At this stage patience is required, the surgeon must not put the collecting tubes under the catheters at once but must wait; he may have to wait three or four minutes, or even longer sometimes, until the last drops of the injected fluid have come away and urine itself begins to flow. When all is going well the manner in which the urine flows from the catheter tubes is always most striking and characteristic. It comes

with the greatest regularity, four or five drops at a time, then a pause for an appreciable interval, and after this another group of drops. Each of these groups of drops represents an "overflow" from the little pool of urine in the bladder in which the other end of the catheter tube is lying and these periodic overflows of course correspond with the rhythmically recurring jets by which the urine normally escapes from the ureter into the bladder. When once the operator is satisfied that all the injected fluid has run off and that urine is now coming he may place the collecting tubes in position; in about twenty minutes he will probably have collected about six cubic centimetres in each tube and the tubes will be full. They can then be replaced by a fresh pair of

FIG. 61.



After Luys and Vale. (*Ann. of Surg.*)

empty tubes and in this way a second, and if necessary even a third, pair of specimens can be obtained."

Figs. 60, 61, and 62 illustrate the segregator and its use. Care must be taken to see that the instrument is in proper working order before introducing it, for if the india-rubber lose its elasticity, it may not pull the chain well into the concavity of the instrument, and then the cogs may still be standing up when the instrument is withdrawn, and the urethra may thus be damaged.

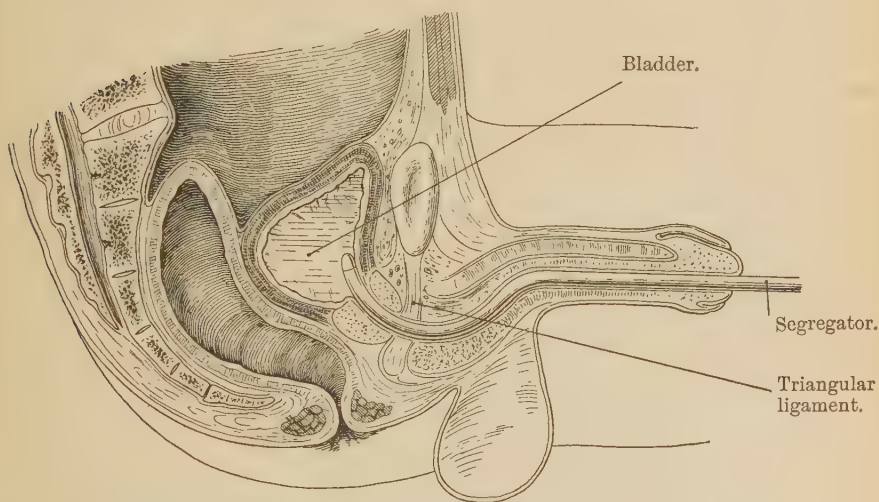
The two following cases of Bickersteth illustrate very well the use of the segregator in the diagnosis of renal tumours from others in their vicinity and *vice versâ*.

CASE 4.—*Large tumour in the right loin simulating hydronephrosis.* The patient, a man, aged 49 years, gave a history of nine months' uneasiness and discomfort from a gradually increasing swelling in the right side. This had now reached a very large size; it seemed to be fluid but it was very tense; it could be pushed forward from the loin. It was unhesitatingly taken for a hydronephrosis and an operation through the loin was

decided upon. On Feb. 2nd, 1904, the separator was applied, the instrument being kept in for thirty minutes. Six cubic centimetres of urine flowed from the right tube; it was clear, of good colour, with slight deposit of mucous and lithates. On cryoscopic examination the freezing point was found to be -2.0° C. Two and a half cubic centimetres of urine flowed from the left tube; it was very pale, with practically no deposit. On cryoscopic examination the freezing point was found to be -1.0° C. This altogether unexpected and surprising result led to a postponement of the operation and to a reconsideration of the whole case. A second application of the separator on the third confirmed the results obtained on the previous day and gave two specimens exactly similar both in character and quantity to those already described, except that one grain of methylene blue having been given hypodermically a quarter of an hour beforehand both specimens alike were beginning to show traces of colour. At the operation, which was performed on Feb. 5th (anterior incision), the swelling proved to be a large pancreatic cyst. The right kidney was normal.

CASE 5.—The patient, a man, aged 40 years, was admitted into the Royal Infirmary, Liverpool, on Oct. 27th, 1903, complaining of severe pain in the left side, especially about

FIG. 62.



The segregator imperfectly introduced. (After Luys and Vale.)

the tip of the twelfth rib, of a dull aching character, but sometimes paroxysmal, radiating down to the left groin but not extending to the testicle. The pain was almost always relieved by the patient lying flat down on his back. He had been suffering like this for two years and was getting worse. "The left kidney was felt to be much enlarged." Under the very natural impression that this was probably a case of calculous pyelitis with a blocked ureter it was decided to cut down into the left loin and to explore this kidney. Examination of the mixed urines showed them to be of specific gravity 1017, acid, clear, pale amber in colour, with no deposit, albumin, or sugar. On Nov. 18th the separator was applied. My note reads: "Instrument passed easily and was kept in for thirty minutes. Urine flowed at normal rate and in equal quantity from both kidneys. The urine is normal, quite healthy, and apparently exactly the same on one side as on the other." Unfortunately, the findings of the instrument were in this case disregarded. It was one of my earlier cases, and as I had not at that time acquired my present degree of confidence in the method I could scarcely expect to convince others of its trustworthiness. On Nov. 24th operation was performed. An incision into the left loin showed an aneurysm displacing the kidney. The mistake was quickly recognised before any apparent harm had been done and the wound was closed. The wound healed and all seemed to be going well,

but about ten days later this patient died without warning and with absolute suddenness. A post-mortem examination revealed the condition to be aneurysm of the abdominal aorta which had ruptured into the left pleura.

Mr. Bruce Clarke (*Lancet*, Jan. 7, 1905, p. 5) and many others have published interesting cases showing the undoubted value of the segregator, which is now in constant use in most of the London hospitals. The following is one of Mr. Bruce Clarke's cases.

"One more instance of the use of this instrument. The patient in question was passing pus from time to time with her urine but the symptoms though pointing to the right lumbar region were not sufficiently marked to make it absolutely certain which of the two kidneys was affected. She had been examined by means of a cystoscope but the urine, even after the bladder had been washed out, was too opaque to make the diagnosis a matter of certainty. The separator was introduced, three grains of methylene blue in a pill having been previously administered. The result was a striking one. The left kidney secreted urine naturally. It came away rapidly and evenly and was deeply stained with the methylene blue and healthy in character. A few drops of urine, opaque and purulent in appearance, passed from the right side shortly after the separator was introduced. No more passed for nearly half an hour, when more fluid of the same character was voided. It was tested for urea and found to contain less than $\frac{1}{2}$ per cent. The diagnosis was consequently placed beyond doubt and the right kidney was removed a few days later. It was little more than a bag of pus and contained some caseous material as well. The upper part of the ureter was much thickened and was removed at the same time. A good recovery resulted."

The Determination of the Functional Capacity of the Kidney.—Ashton Berg (*Ann. of Surg.*, May, 1906, p. 724), has contributed an able discussion upon this important subject, and much of what follows has been derived from his paper.

He points out that the problem is a threefold one; we want to discover the amount of: (a) The combined work of the kidneys; (b) the individual work of each; and (c) the probable amount of work that each is capable of doing if its fellow is excised or seriously damaged.

(a) The combined work is estimated from (i.) the cryoscopic index of the blood, and (ii.) the amount of urea discharged in 24 hours.

(b) The individual work is determined from (i.) the percentage of urea in the individual urines, (ii.) the amount of sugar and chromogen in each urine after an injection of Phloridzin and methylene blue, (iii.) and the cryoscopic index of each urine.

(c) The potential functional power of each kidney cannot be estimated with any degree of accuracy from the results of (a) and (b).

D. Cryoscopy.—Koranyi was the originator of this method of investigation which aims towards estimating the functional capacity of the kidneys by means of determinations of the freezing points of the blood and urine.

Kümmel, Rovsing and others have written much upon this subject ("German Surg. Congress," 1905; *Lancet*, vol. i. 1905, p. 1536).

(i.) *The cryoscopic index of the blood.*—The freezing point of normal blood is from 0.56° to 0.60° C. below that of distilled water; when the solids increase from deficient renal excretion the freezing point falls below 0.60° C., and it also falls in certain diseases accompanied by deficient oxidation such as large abdominal tumours, cardiac and respiratory insufficiency, &c.

In severe anæmia the blood is so thin that considerable retention of

potential urinary excretions may occur without a fall of the freezing point below 0.60° C.

Dr. Berg concludes that "the cryoscopic index of the blood merely indicates the work that is being done by the renal organs: *it teaches us nothing of the health or disease of the kidneys*, for three-fourths of the total kidney-tissue may be destroyed and yet the remaining one-fourth will be sufficient to maintain the normal molecular concentration of the blood; nor does it afford an indication of their potential functioning power. Only in connection with the health or disease of the individual organs can the freezing point of the blood be considered as a help in this respect."

"(a) A normal cryoscopic index of the blood when there is one healthy and one diseased kidney would indicate a potentially sufficient functional capacity of the sound organ, and would warrant us in doing a nephrectomy.

"(b) An abnormally low cryoscopic index of the blood when there is one healthy and one diseased kidney does not indicate potential insufficiency of the former for the function of this organ may be only temporarily impaired by the diseased fellow organ. In such a case nephrectomy may nevertheless be done safely.

"(c) A normal cryoscopic index of the blood when there is one slightly diseased and one extensively diseased organ would usually point to a potentially sufficient functional capacity of the less diseased organ, and would allow of our doing a nephrectomy or other operation upon the more affected kidney.

"(d) A normal cryoscopic index of the blood when there is more or less extensive affection of both kidneys does not mean a potentially sufficient functional capacity of these organs, and does not permit of our removing one or even of incisively attacking either organ.

"(e) An abnormally low cryoscopic index of the blood with more or less extensive disease of both kidneys indicates their potential insufficiency and strongly speaks against the advisability of doing any operation upon them."

From the above it is clear that too much reliance must not be placed in this one source of information, and to reject all patients with a freezing point of the blood below 0.60° C. as unsuitable for nephrectomy or major operation is absurd. Dr. Berg has performed nephrectomy when the freezing point has been as low as 0.65° C. and 0.67° C., and the patients have recovered.

(ii.) The cryoscopic index of the combined urines is of far less value, because the freezing point of the urine normally varies from 1.2° to 2.2° C. below that of distilled water; this is due to variations in the circulation, nervous influence and especially the amount of fluid partaken. If the freezing point falls below 1° C. under normal conditions, renal excretion may be assumed to be deficient.

A comparison of the freezing points of the separated urines may however be valuable, and may indicate the proportion of the work done, and with less certainty the comparative amount of renal tissue in the two kidneys.

E. Estimation of the average total amount of urea passed in the 24 hours is of value; it should be about 350 to 400 grains in a healthy person in bed on farinaceous diet, if it is below 300 grains renal insufficiency may be assumed. Mr. Clement Lucas many years ago, relying upon this test, refrained from removing a seriously damaged tuberculous

kidney. The patient died of diphtheria and was found to have only one kidney. *A comparison of the percentage of urea in the separated urines* is of more value for it enables us to tell which is the diseased or the most diseased of the two kidneys. Rosving relies upon this and a careful examination of the separated urines, and he "maintains that a kidney which secretes healthy urine containing a normal percentage of urea is functionally sufficient and may be relied upon to satisfactorily perform the full work of the body."

The Methylene blue test.—The bladder being empty and the segregator or ureteral catheters introduced a sterilised solution of 0.05 grm. of methylene blue may be injected beneath the skin of the flank. The urines from the two ureters may soon differ in colour. The time of onset, the rapidity and duration of the elimination by each kidney should be estimated, and from these data the comparative functional capacity of the two kidneys may be inferred.

The Phloridzin test.—Phloridzin (0.005 grm.) is injected subcutaneously and the amounts of sugar appearing in the separated urines is estimated, and from a comparison of these amounts the functional activity of each kidney may be inferred.

These tests are of little value in determining the potential functional capacity of the kidneys, except when the state of the kidneys as regards presence or absence of disease is known from other sources, such as a thorough examination of the separated urines.

In conclusion it may be stated that valuable information may be obtained by *a careful, skilful and combined study of*

- (1) The cryoscopic index of the blood.
- (2) The percentage of urea in the separated urines.
- (3) The chemical, microscopical and bacteriological examination of the separated urines.
- (4) A comparison of the freezing points of the separated urines.
- (5) The average total amount of urea passed in the 24 hours.
- (6) Rate of excretion of methylene blue and sugar in the methylene blue and Phloridzin tests.

The urines should be separated by means of the segregator and not by ureteral catheterisation, which Berg, Rosving and others recommend.

The following case may serve to show the value of some of the modern methods of diagnosis of urinary diseases. A middle-aged man was admitted into Guy's Hospital, under the care of Sir Cooper Perry, suffering from attacks of hæmaturia. The bleeding was profuse and painless but it lasted only for a few hours at a time. In the intervals the urine was healthy. There were no abnormal physical signs in the loins or along the course of the ureters; there was some dull pain over the sacrum. A radiographic examination was negative. On examining with the cystoscope I proved the absence of villous or other growth of the bladder, and found the bladder to be normal except for a slight enlargement of the right ureteral orifice and some congestion around it. The patient never had an attack of bleeding when in the hospital, although he was encouraged to take exercise, and to go up and down stairs; and bimanual pressure in the loins failed to send any blood down the ureters during cystoscopic examination. Later the man returned, bringing with him a ureteral cast, and now he had a slight varicocele on the right side.

The segregator was introduced, and the urine issuing from the right side was paler than that from the left, and the former contained 2.3 per cent. of urea, while the latter only had 1.3 per cent. Control examinations gave similar results. The centrifuged right urine showed crenated red blood corpuscles and large round cells of growth, whereas the left urine was normal. Cryoscopic examination of the separated urines by Dr. Bell Walker confirmed the conclusion that the right kidney was doing much less work than the left. The total amount of urea was satisfactory. A diagnosis of malignant growth of the right kidney was made with confidence, and this was proved upon exposing the kidney,

which was fairly fixed and hidden high up in front of the ribs. The kidney was removed without hesitation, for it was known that the other one was normal in function. The patient unfortunately died from lobar pneumonia of the left lung a few days later. There were no secondary growths anywhere.

NEPHROTOMY.

Indications.—The following are the principal conditions which demand this operation:—

i. **Pyonephrosis and Abscess of the Kidney.**—When due to tuberculous disease, and the tumour is large, or the patient is not in a condition to stand primary nephrectomy, nephrotomy should be performed as a preliminary measure; when, however, there is evidence of disease of the opposite kidney or of other viscera, nephrotomy alone is available. The results, however, when a secondary nephrectomy cannot be performed are, as might be expected, extremely unsatisfactory. Otto Ramsay, of Baltimore (*Ann. of Surg.*, vol. ii. 1900, pp. 461 *et seq.*), gives the results of fifty-five cases. Of these, four at the most, and probably two only, can be considered as cured.

When the abscess is due to calculi, these will be removed and the cavity drained, except in special cases where nephrectomy is indicated (*vide infra*, p. 180).

In a few rare instances pyonephrosis may be due to a stricture of the ureter. An example of this condition is referred to below under the Surgery of the Ureter (*vide p.* 254).

ii. **Hydronephrosis.**—If the kidney has been entirely destroyed, and the size of the tumour prevents removal, incision and drainage should be employed either as a method of cure or as a preliminary to a secondary nephrectomy.

iii. As an exploratory operation for diagnostic purposes for certain obscure renal symptoms. Some of the conditions that have been found are mentioned below under Nephro-lithotomy (*vide p.* 166); in others a calculus will be found. In others again, particularly where the only symptom is hæmaturia, the exploration may have a negative result.

Hurry Fenwick (*Brit. Med. Journ.*, vol. i. 1900, p. 248), however, records two striking cases of operation for unilateral painless renal hæmaturia.

In the first case, a young lady, aged 18, had suffered from attacks of hæmaturia for five years, causing marked anæmia. With the cystoscope the blood was seen to come from the left ureter. At the operation the left kidney was brought out on to the loin, the pelvis incised and illuminated with electric light. It was then seen that one of the renal papillæ was of a bright red colour, and appeared to be villous on the surface. The papilla and half the pyramid were removed with a Volkmann's spoon. No hæmaturia has occurred since the operation.

In the second case there had been alarming hæmaturia for a fortnight, producing profound anæmia. The blood was seen to come from the left ureter. The operation was similar to that performed in the first case, as was also the condition found. This case was likewise completely cured.

iv. **Anuria.**—This will be dealt with later (*vide* p. 190).

v. **Nephritis.**—Dr. Alfred Pousson read a paper on the surgical treatment of nephritis at the International Congress of Medicine at Lisbon, April, 1906 (*Lancet*, vol. i. 1906, p. 1202). The following summary of his views is taken from the *Lancet*.

"Four operations have been suggested for acute nephritis—namely, nephrectomy, total or partial, nephrotomy, and decapsulation. Nephrotomy acts by relieving tension and by local bleeding. Decapsulation only reduces the compression of the kidney. The mortality of all forms of surgical interference is only 15·4 per cent. and the patients who have survived the operation have done well. This mortality justifies surgical intervention in acute nephritis, but only in severe cases which have failed to respond to medical treatment. Acute nephritis is often unilateral and the affected side can generally be diagnosed, especially by means of cystoscopy and separation of the urines of the two kidneys. In cases where both kidneys are affected the treatment of one often relieves the other. Nephrotomy is the operation of choice for acute nephritis. Nephrectomy should be reserved for cases where there are severe lesions limited to a single kidney. Decapsulation is much inferior to incision of the kidney. In chronic nephritis surgical intervention can do much but it should only be employed where medical treatment can do no more. Nephrotomy is less dangerous than decapsulation and it should be preferred. It is difficult to speak with certainty, but decapsulation seems to be the only operation which gives a hope of a radical cure of chronic nephritis, but it is best to combine with it a unilateral nephrotomy."

I do not recommend any of the above procedures, which are highly experimental; the results that have been published so far are certainly no better than those obtained by the far safer medical treatment. The same remarks apply to the *Treatment of eclampsia by nephrotomy* introduced by Edebohls and advocated by Chamberland and Pousson in a paper read before the Paris Academy of Medicine, April 3rd, 1906.

Operation.—As this is identical with the first stages of a nephrolithotomy the reader is referred to the description of that operation (*vide* p. 172).

NEPHRO-LITHOTOMY.

The following are the chief symptoms and conditions justifying nephro-lithotomy:—

I. *Continued Hæmaturia, or Passage of Blood.*—I may at once be criticised for putting this first; and, indeed, it is somewhat difficult to decide which symptom of renal calculus is clinically the most important.* On the whole, I am inclined to agree with an old friend, G. A. Wright, of Manchester (*Med. Chron.*, March, 1887, p. 463), who considers "renal hæmaturia as the only single symptom of anything like cardinal importance," if without evidence of nephritis.

A few words as to the character of the hæmaturia of renal calculus and the fallacies which must be borne in mind. It is a hæmaturia of long standing, often repeated, frequently increased by exercise or jolting, rarely profuse, and never producing anæmia, as in growth of the kidney. Always intimately mixed with the urine, the tint varies

* Being convinced of the frequency of errors of diagnosis in renal calculus, I have dealt with these fully. I may also refer my readers to my paper, *Brit. Med. Journ.*, 1890, vol. i. p. 117.

from a bright or deep red (which I think are rare) to a smoky or porter-like colour.

Fallacies: (a) Hæmaturia may be absent from first to last. This, an undoubted fact, is one very difficult of explanation. It was the case with the smaller calculus (Fig. 63). And this is the more extraordinary as the stone is covered with minute crystalline spicules, a condition which would have appeared certain to lead to oozing from the inflamed mucous membrane of the pelvis in which the stone lay. The only explanation that I can give is that at the operation I found the abdominal muscles extremely rigid; even when the patient was fully anæsthetised, they gave the impression to the scalpel of cutting through tissues frozen by ether. Now, if it is fair to suppose that on the other side of the kidney the quadratus and psoas were as firmly contracted, the kidney and the stone in its pelvis may have been so firmly held that no irritation by the calculus could take place, and thus no hæmaturia. (b) Another fallacy is that the hæmaturia of calculus may be only temporary, present for a while and then ceasing altogether. This occurs, though rarely, when a small renal calculus becomes encysted. (c) The value of hæmaturia, though only occasional, is shown by a case of Dr. Owen Rees', to which Mr. Morris has drawn attention.

It was that of a young lady with lumbar pains and frequent micturition, which were both put down to the hysteria that was markedly present. After a while, hæmaturia was found to be present on several occasions, and eventually, after death, a mulberry calculus was found in one kidney.

Other fallacies are presented by the host of kidney conditions which may give rise to hæmaturia—namely, (1) the passage of uric acid crystals; (2) tubercular kidney; (3) granular kidney; (4) growths; (5) increased intra-renal pressure, &c. To these I shall refer later.

2. *Pain and Tenderness, Lumbar and elsewhere.*—(a) **FIXED LUMBAR PAIN.**—Characters: Generally dull, gnawing, pricking, or aching, increased usually by exercise, twisting from side to side, or flexing the body.* Sometimes it is relieved by pressure of the hand, leading to thickening and vascularity of the parts when they are incised at the operation. (b) **RADIATING PAIN**, for example, in the testis,† region of the small sciatic nerve, calf, foot, or in the intestine simulating colic. It is easy to see how readily the pain of a renal calculus, if limited to distant parts, and if occurring without hæmaturia, may mislead. Another point with regard to the pain of renal calculus is the frequency of nocturnal exacerbations. The explanation of this is doubtful, whether, as Mr. Morris has suggested, from the passage of flatus in the colon, at this time over a stone in the pelvis, or, as I venture to think more probable, as accounting for stone whether in

* As in going upstairs; probably from the pressure on the kidney by the contracting psoas. But the relation of the pain to movement, and the kind of movement which most induces pain, vary greatly. Thus Mr. Butlin's patient is said to have suffered greatest pain when driving, least when riding. Prolonged walking seems the most frequent cause.

† In a case of Mr. Butlin's (*Clin. Soc. Trans.*, vol. xv. p. 113) the patient sought relief from severe neuralgia of the right testis, which was generally retracted and extremely tender. Later on it was noticed that these neuralgic attacks were associated with some lumbar pain and tenderness. Complete recovery followed after the removal of a small, prickly, calcium-oxalate calculus from the pelvis of the right kidney.

the pelvis or in one of the calyces, to the concentration of the urine, and consequent deposit of crystals, which takes place at night, is unsettled. The fact, however, is undoubted.

In the case of a patient, aged 58, who had suffered from symptoms of renal calculus for thirty years, and from whose left kidney I removed the huge calculus (Fig. 63), the pain at night was often so severe as to drive him from his bed into his garden or the streets of the town in which he lived.

(c) RENAL COLIC.—Very acute in character, radiating from the loin, usually downwards, and accompanied often by rigors, nausea, vomiting, and profuse perspiration. The attacks are usually recurrent, and vary greatly in severity.

On the other hand, pain is, much more rarely, absent.

With regard to *tenderness*, Mr. Jordan Lloyd (*Pract.*, vol. xxxix. p. 178), in a paper to which I shall have again to refer, writes thus: "I attach great importance to the evidence to be obtained by immediate percussion over the suspected organ, a method of investigation which has not received that amount of attention to which it is entitled. It is best practised from the loin, just beneath the space between the tips of the last two ribs, and should be made in a direction upwards, forwards, and slightly inwards. It is best for the patient to stand upright before you. The blow should be sharp and decisive, and of force sufficient to affect a structure situated several inches below the surface. It may also be practised from the front, at a point midway between the umbilicus and ninth rib. When a calculus is present, the patient will complain of sharp, stabbing pain at the moment of percussion. Other conditions doubtless give rise to percussion pain, but not of the characteristic stabbing of calculus."

I have tried the percussion test of Mr. Lloyd in many of the cases which have come under my hands for nephro-lithotomy (table, p. 188) since his paper was published. In three the tenderness was increased, but in one only was there any "characteristic stabbing." In this, where a small and very spiculated oxalate of lime calculus occupied the top of the left ureter, the patient at once said, "You stab me there." This patient, No. 5 in the table, was thin and spare. Tenderness more or less marked will, however, be usually elicited by making firm pressure upon the kidney between the two hands, one placed in front and one behind the kidney.

Mr. Clement Lucas (*Hunterian Lecture*, 1903; *Lancet*, vol. i. 1903, p. 1148) recommends a new test, which he calls "the stamping test," which "sometimes gives the most remarkable results. The patient supports himself by resting one hand on some firm object, then is told to flex the thigh on the suspected side as high as possible. The psoas muscle being thus strongly flexed, by its contracted belly presses the kidney forwards and outwards. Next the patient brings the limb suddenly down, stamping the heel firmly on the ground. The kidney in this way suddenly loses its muscular support and is caught, as it were, unawares, whilst the jar carried through the pelvis and spine is communicated to it. A sudden acute pain is commonly caused by this manœuvre when a calculus is present. In one case in which I employed this test it answered only too well, for the patient was immediately seized with acute renal colic which necessitated his being put to bed,

where he lay for some hours in great agony. It was evident that a stone had been displaced from a calyx and had fallen over the outlet of the pelvis whence it was removed by operation some days later."

3. *Points in the Previous History.*—Space will only allow of my noticing a few of those given above, namely, lithiasis and oxaluria, history of previous passage of a stone, history of previous colic.

The history of long-standing lithiasis and oxaluria is of obvious importance, from the fact that the habitual passage of crystals or gravel and the formation of a calculus lie not far apart. But there is another point which has not, I think, received sufficient attention, and that is, that in patients who have habitually, for many years, passed uric acid and oxalate of lime, there is a most serious risk that the minute anatomy of their kidneys will have become seriously damaged by the constant presence of the above crystals. We should all be agreed as to the damaging effect of multiple calculi on the secreting tissue of the kidney. I would suggest that in the future the results on the kidney of the daily passage of crystals of uric acid and lime oxalate must receive sufficient attention before patients at all advanced in life are submitted to nephro-lithotomy. Furthermore, it is obvious that long-continued lithiasis and oxaluria will very likely have led to the formation of bilateral stones.

Under the heading of Renal Colic, I would point out that the vomiting and nausea which are thought to be characteristic of the agony of a descending calculus may also be caused by a stone which is distending the renal pelvis, but has not yet begun to make its way down.

4. *Frequency of Micturition.*—The co-existence of irritability of the bladder with renal calculus is well known, and may be explained either by nerve disturbance, or by the blood and pus, or the over-acid urine which often accompanies stone in the kidney.

A point with regard to bladder irritability is that it may be of value in making the most difficult diagnosis between a calculus and a tubercular kidney. Thus, if a patient with hæmaturia, lumbar pain, &c., has irritability of the bladder which is not relieved by rest in bed, but which continues by night as well as by day, it is probable that this is due not to trouble in the kidney alone, but to co-existing ulceration of the bladder, and this will probably be confirmed by cystoscopic examination, and sometimes by examination of the prostate and vesiculæ seminales in the male, and by digital exploration of the bladder in the female.

5. Pyuria, especially when unilateral in origin.

6. Localising evidence obtained by the X-rays, the segregator and the cystoscope (*vide* p. 150).

7. *Failure of Previous Treatment to give Relief.*—I can only touch on one point here—*i.e.*, the question of the advisability of trying to exert any solvent action on a calculus in the kidney. Whilst, for myself, I attach the greatest importance to the use of large quantities of water, it is rather because this, by washing out the kidneys, removes collections of crystals, and gets the patient into a better state for operation, than because I believe in its possessing any actively solvent action upon the calculus. I do not forget that Sir W. Roberts has proved by experiments on calculi, both those without the body and those in the bladder,

that urine rendered alkaline by fixed alkali has a distinctly solvent action.

Dr. Ralfe has reported (*Path. Soc. Trans.*, vol. xxxiii. p. 206) a case of a patient, aged 37, who, after suffering from uric acid gravel for some years, had a violent attack of renal colic, with profuse hæmaturia, no calculus or gravel being discharged. Alkaline treatment was at once resorted to, and for a time afforded relief, but the patient could not be persuaded to continue it systematically. He was then ordered to drink copiously of soft water—filtered rain-water. Two years later he began to pass grit and scales of calculous matter with his urine; and shortly afterwards, after a severe attack of colic, he passed the shell of what had evidently been a solid calculus.*

But it must be remembered that, as my late colleague Dr. Hilton Fagge pointed out (*Medicine*, vol. ii. pp. 373, 383), such solvent treatment is only worth trying in the case of uric acid calculi. He at the same time showed that the greater relative frequency of lime oxalate calculi over those of uric acid, especially in patients after early adult life, is much more marked than is generally believed. Moreover, as Morris (*Hunterian Lectures*, 1898) points out, it cannot be too strongly urged that, in the presence of definite symptoms of calculus, any prolonged course of palliative treatment is to be deprecated, for during this time the stone may be steadily but slowly destroying the kidney, and so valuable time will be lost.

8. *Calculous Anuria*.—Exploration of the kidney in this extreme condition is urgently called for, although in a few cases recovery has taken place without operation. Morris (*loc. supra cit.*) gives two collections of cases, those operated on and those not operated on. Of forty-eight cases not operated on, ten, or 20·8 per cent., recovered; of forty-nine cases operated on, twenty-five, or 51 per cent., recovered. These figures speak for themselves.

The most important and difficult point to decide is the question as to which kidney should be explored. If it can be determined which kidney has become the more recently affected, this should be chosen for operation, because this kidney will be the one that is least destroyed by disease. Apart from history, abdominal pain, rigidity, and tenderness may help to clear up this point. This subject is again referred to later, p. 190.

Conditions which may simulate Renal Calculus.—Before deciding to operate on a given case, it must be borne in mind, in addition to what has been already said, that many other diseases may give rise to the same symptoms as renal calculus.

So closely do some of these conditions simulate renal calculus that a correct diagnosis can only be arrived at by means of an exploratory

* Dr. Ralfe (*Diseases of the Kidneys*, p. 523) points out that the solvent action of distilled water is due to several influences. In the first place, by causing a low specific gravity of the urine, it induces disintegration, since Rainey has shown, experimentally, that bodies placed in solutions of different density to those in which they were formed undergo molecular disintegration. Again, chemical analysis has shown that those calculi that undergo spontaneous disintegration are always poor in inorganic constituents: the use of soft water diminishes the supply of these, even if it does not actually act as a solvent on those forming the outer crust of the calculus, and so increases the tendency to disintegration. Lastly, soft water probably diminishes the catarrh of the urinary passages, and by diminishing the swelling of the mucous membrane allows a small stone to pass which was before obstructed.

operation. Morris (*loc. supra cit.*) gives a list of no less than forty-four cases occurring in his own practice in which the kidney was explored for stone, and no stone found. In a few of the cases a calculus was passed soon afterwards, so may have been lodged in the ureter at the time of the operation. In the majority of the cases, however, some other morbid condition of the kidney or ureter was found and remedied. So that, although no stone was found as the result of these operations, no harm was done in any (for none were fatal), and good was done in the majority. Morris says: "It is certain that the diagnosis of calculus, though incorrect, was advantageous to the patients, for the very reason that it led to the exploration, and in this way to the discovery of the true cause of the disease."

These conditions simulating calculus must now be severally considered. They may be usefully divided into two groups—affections of the kidney and ureter, and diseases of other organs.

A. Affections of the kidney and ureter which simulate renal calculus.

1. *Lithiasis*.—I have already alluded to this condition as one which simulates renal calculus by the hæmaturia which crystals of uric acid may cause. Lumbar and testicular pains are also points which mere lithiasis shares with renal calculus. The diagnosis will not be difficult by watching the result of treatment, which only gives relief in the one, but clears up the other. Exercise, again, is a test.

2. *Tubercular Kidney*.—Lumbar pain and tenderness, frequent micturition, hæmaturia, are all common to tubercular kidney and renal calculus. The chief aids in the diagnosis appear to me to be: (a) the pyuria; (b) careful examination of the urine; (c) early pyrexia; (d) early exploration of the kidney; (e) the comparative slightness of the pain and the infrequency of radiating pain or colic; (f) the corresponding ureter may sometimes be felt to be enlarged and tender by vaginal examination (Clement Lucas, *loc. cit.*).

(a) *Pyuria*.—This is usually present early in the case with a proportionate amount of albumen, without much hæmaturia, the blood often occurring only as a thin layer over the pus at the bottom of the urine-glass, or as small, thready clots. With all the pus the urine is strongly acid at first, then more feebly so, but often remains slightly acid to the last. (b) Careful examinations of the urine.—The sediment contains caseous matter, and sometimes *débris* of connective tissue can be made out, a point of much importance. Finally, there is the bacillus tuberculosis. While I am well aware of the frequent want of success in demonstrating the presence of the bacillus in urine as in bone, I may add that it was found in six out of the thirteen cases in which I have been asked to explore tubercular kidneys.* (c) *Pyrexia*.—I do

* I may point out here that bacteriology will help the surgeon in difficult cases. My colleague, Dr. Washbourn, has thus cleared up two obscure cases for me. One, a delicate woman of 32, with a tubercular history, was sent to me by Dr. Forty, of Wotton, in Gloucestershire, with obstinate cystitis and irritable bladder. The endoscope and digital exploration showed swollen and hyper-vascular mucous membrane, but detected no ulceration. Wiping over the mucous membrane with a solution of silver nitrate (gr. xl.—ʒi) was followed by very great relief lasting over two months on two occasions. At my request Dr. Washbourn injected some of the pus containing urine (in which no bacilli could be found) under the skin of a guinea-pig. No result apparently followed, but

not here speak of the hectic which accompanies the advanced stage, but of the pyrexia which may be an important factor in the diagnosis much earlier in the case. Often intermittent at first, and liable to be overlooked in the anorexia, nausea, and debility which accompany it, later on, and too late, it becomes only too evident and confirmed. (d) Early exploration of the kidney.—Morris mentions seven cases in which tuberculous foci were found in the kidney and excised; but in three of these secondary nephrectomy had to be performed later, the other four remaining well for from two and a half to four and a half years. In one case three separate wedges of kidney substance were removed, and the resulting gaps in the kidney closed by sutures. This matter is referred to later, p. 216.

3. *Hydronephrosis* due to stricture of the ureter, or a valvular obstruction at the commencement of the ureter. Several remarkable cases of this nature have been described, notably those of Morris and Fenger. These will be referred to later, pp. 250, 254. Mr. Bruce Clarke has also published (*Lancet*, vol. ii. 1891, p. 984) two cases of this kind in which the cause was not found. The first was perhaps an early stage of hydronephrosis, and the pain a very prominent feature, dull and aching, with severer attacks; but, as it was found at the operation that "the kidney pelvis was very slightly dilated," the case is not decisive. The second is more convincing. The kidney here was dilated and a mere shell, no cause being found. There was a definite history of several attacks of renal colic, and Mr. Bruce Clarke thought that these had probably been caused by kinking of the ureter.

4. *Slight Pyelitis, not Tubercular*.—This condition may, by hæmaturia, pus in the urine, lumbar and testicular pain, simulate renal calculus closely. It may follow a gonorrhœa, perhaps a previous stone, or occur in women after pregnancy; perhaps, as Dr. M. Duncan thought, from some parametritis extending up the psoas to the peri-renal fat and kidney.

5. *Movable Kidney*, especially if associated with neuralgia, pyelitis, or if recurring with some of the reflex causes of nephralgia to be mentioned below. The following case under Mr. Watson Cheyne (*Brit. Med. Journ.*, vol. i. 1899, p. 17), in which there was severe hæmaturia, caused probably by congestion due to kinking of the renal vessels, is worthy of note in this connection.

A woman, aged 40, had a fall, hurting her back, in 1885. This caused great pain and hæmaturia, the urine being bright red in colour. This continued for five weeks, during which time the patient was confined to bed, and then ceased. There was no further hæmaturia for ten years, although pain was present during most of the time. Severe hæmaturia then occurred again, and again stopped after a time. In June, 1897, severe hæmaturia and pain came on again, and continued till November, when the operation was performed. No stone was present, but the kidney was found to be freely movable. The kidney was fixed, with the result that hæmaturia ceased immediately and did not recur.

6. *Ureteritis*.—The following is a very striking instance of this rare disease, described by Israel (*Berl. Klin. Woch.*, xxvii., 1893):

A young man, aged 28, had for eight years suffered from a urinary affection which began with frequency of micturition. Soon acute attacks of pain in the bladder and left

when the animal had been killed, *one* of the nearest chain of glands was enlarged and caseating. A few undoubted bacilli tuberculosis were found in it. This and the other case will be found in the *Guy's Hosp. Rep.*, 1890.

renal colic of extraordinary severity began. The clinical examination in corroboration of the patient's account left no doubt as to the presence of renal calculus: there were frequently blood and mucus, but no tubercle bacilli, present in the urine; there was also tenderness in the left flank, and pain was caused by pressure on the ureter through its abdominal course. The kidney was explored, and found to be small and soft, but no calculus was present. The wound healed rapidly, but the symptoms continued as bad as ever.

Two months and a week later the kidney was again explored, and then it was discovered that the ureter throughout its length was extraordinarily hard, of nearly three times its normal diameter, and presented at intervals enlargements of quite cartilaginous consistence. The ureter was permeable from kidney to bladder, but at three points slight obstructions were present, due to folds of thickened mucous membrane, the result of ureteritis. Nephrectomy was performed, and resulted in a complete cure.

7. *Aching Kidney*.—Under this title Dr. M. Duncan has described a condition, especially common in women, which may simulate renal calculus. Its chief features are a heavy, wearying pain, deep in the side, usually accompanied by tenderness, often great; the pain may run in the course of the great sciatic or anterior crural, and is frequently accompanied by irritability of the bladder, and by pain in the course of the ureter. The disease is liable to be aggravated by exercise. The chief points in the diagnosis of this condition are, Dr. Duncan points out, the absence of blood and pus, the fact that the "aching" often occurs only at the menstrual periods and is always worse then, from the intimate connection between the kidneys and the generative organs, not only developmental but pathological. A definite nephralgia is also caused sometimes by malaria, as pointed out by Morris, and may be relieved by the administration of quinine.

8. *Interstitial Shrinking Nephritis*.—This condition may simulate renal calculus both by hæmaturia and pain.

Dr. S. West (*Lancet*, 1885, vol. ii. p. 104) drew attention to the hæmaturia which may accompany granular kidney, and published three cases, aged 21, 19, and 24; in the first the hæmorrhage was profuse. Mr. Bowlby (*Clin. Soc. Trans.*, vol. xx. p. 14) also published three cases, aged 73, 49, and 64; two of these died, and the kidneys were found markedly granular. He points out the following as distinguishing this condition from renal calculus: The specific gravity of the urine, after the blood has cleared up, only 1008 to 1015; tortuous arteries, cardiac hypertrophy, and high arterial tension; blurred, ill-defined discs, some retinitis and effusion amongst the blood-vessels. The paper concludes with the following warning: "Unless it be recognised that blood may emanate from a kidney which is simply granular, operations may be undertaken for the removal of renal calculus."

With regard to renal pain in granular kidney, this is of two kinds. There is the dull aching generally found, if the case be watched, to be felt across both loins, as well as in one side. Occasionally, though this is rarer, the pain occurs in violent paroxysms, simulating renal colic. This was so in the case to which I have alluded, and to a more marked degree in one brought by Mr. Mansell Moulin before the Clinical Society (*Trans.*, vol. xxv. p. 60). If now, in addition to the hæmaturia and paroxysmal pain, there be nausea, passage of uric acid, and frequent micturition, the mistaken diagnosis of calculus may easily be made. Where granular kidney is possible, such a case should be carefully watched, and if the specific gravity of the urine never rises above 1015, the question of operation must be entertained with the greatest caution, and the very great risks most clearly put before the patient.

9. Renal growths, in these pain and hæmaturia are independent of jolting and other movements, the bleeding is more abundant, and it is as little controlled by rest as it is unlikely to be induced by exercise (Morris).

Other conditions mentioned by Morris as having been found in some of the above-mentioned forty-four cases are—small abscesses, or suppurating cysts, solid renal or peri-renal tumours, tense cysts, blood extravasated either under the capsule or within the substance of the kidney, dense adhesions. To these may be added rare cases of villous tumour of the pelvis, nævus of the pelvis, and primary cystic kidney.

B. Diseases of other organs which may simulate renal calculus.

1. *Gastric and Duodenal Ulcer*.—Morris has seen a case of gastric ulcer which simulated renal calculus, and Ralfe (*Brit. Med. Journ.*, 1888, vol. i. p. 183) gives one which he thinks was due to duodenal ulcer.

Thus, a patient had many symptoms of renal colic, and three attacks of paroxysmal pain accompanied by vomiting, great tenderness in the right renal region, urine loaded with uric acid, but no pus or blood. The patient, who was losing flesh, recovered with treatment directed to duodenal ulcer.

2. *Intestinal Adhesions*.—A case is given by Dr. Tirard (*Lancet*, vol. i. 1892, p. 16). Though (as the kidney was only punctured) the presence of a calculus cannot be excluded in this case, it is very possible that the explanation given below may meet other nephralgias. A schoolboy, aged 12, gave a history of hæmaturia with severe pain, after another boy had jumped suddenly and roughly on his back. There was only this one attack of hæmaturia, but from this time occurred frequent attacks of severe pain, which seemed to return with any sudden jolting movements, a railway journey or a ride in a hansom often proving sufficient exciting cause. It was also noticed that the pain was worse with constipation or diarrhœa. Although no certainty was felt about the presence of a renal calculus, it was generally thought that the symptoms might be due to this. At the operation no stone could be found, though the pelvis and the substance of the kidney were carefully explored with a needle. A firm cicatrix was, however, discovered, circling the capsule of the kidney and the descending colon, and this was so tough and so extensive that it was thought expedient not to divide it. The lad recovered, and is now able to keep fairly free from pain so long as he attends closely to the action of the bowels.

3. *Gall Stones retained in the Gall Bladder* may be taken for right renal calculus. Dr. Murchison pointed out long ago that they not infrequently coexist. My old friend, G. A. Wright, of Manchester, has recorded (*Lancet*, 1885, vol. i. p. 563) a case in which the right kidney was explored for a calculus believed to be in the ureter.

On exploring this tube a hard spot was felt near the brim of the pelvis, and taken for a stone in the ureter. A calculus the size of a pigeon's egg was removed and found to be a gall-stone. Acute peritonitis carried off the patient, and a stone was found to exist in the pelvis of the right kidney, with its apex in the ureter.

While on this subject of nephralgias due to conditions of viscera near the kidney, I may refer to some remarks of Mr. Godlee (*Pract.*, vol.

xxxix. p. 246), in which he insists that repeated attacks of intestinal colic, especially if accompanied by nausea, may be the only symptoms of the presence of either a renal or biliary calculus, and that this fact should lead the practitioner to investigate the state of the kidney and urine, bearing in mind the possibility of the symptoms being due to renal or biliary calculi.

4. *Spinal Disease*.—The great difficulty which may arise in diagnosing between certain cases of spinal caries and renal calculus is not yet sufficiently recognised. A writer already quoted from (G. A. Wright, *Med. Chron.*, No. vi. p. 642) thus alludes to this matter :

“Where a local patch of caries of a vertebral body exists, and especially where deep suppuration occurs and presses upon the kidney, as in a case of my own and one or two others which I have seen, nearly all the symptoms of a calculus have been present. In my own case, without any deformity or tenderness of the spine, there was unilateral rigidity, testicular pain, intermission of symptoms, increased frequency of micturition, nausea during attacks, and oxaluria, with local pain and tenderness. Subsequently an abscess developed, and on exploration a small patch of caries was found, and the kidney was felt exposed in the anterior wall of the abscess cavity. Probably, as in floating kidney, obstruction of the vessels and ureter may arise and cause symptoms, so that pressure of the spinal abscess may disturb the kidney, and quite possibly give rise to hæmaturia.”

Mr. Clement Lucas relates even a more striking case (*Lancet*, vol. i. 1903, p. 1148).

“*Caries of the spine*, especially in children, may give rise to one-sided backache and radiating pains in front as a lumbar abscess is gradually forming, very similar to what is met with as the result of renal calculus. The pressure of the abscess on the renal vein may even cause hæmaturia, as I once saw very remarkably demonstrated some years ago. I was asked to go to Thetford to meet Dr. M. Beverley of Norwich in regard to the daughter of a medical man. She had spinal disease in the lower dorsal region and lately had been passing blood with her urine. I found a large lumbar abscess which I opened and drained. The blood entirely disappeared from the urine on the second day after the operation. A few months later I received a letter from the father to say that hæmaturia had again appeared. I wrote back : ‘Look out for an abscess on the other side of the spine.’ This was discovered and opened when the hæmaturia again and finally disappeared. I have seen this young lady as a plump well-developed woman showing little or no evidence of the serious illness which she passed through at the age of nine years.”

5. Diseases of the bladder, such as calculus, papilloma, epithelioma and tuberculosis, sometimes mimic the symptoms of renal disease, and fruitless explorations of the kidneys have been undertaken, before the real seat of the disease has been discovered to be in the bladder; thus tuberculous disease, villous growth or epithelioma situated at or near one ureteral orifice may obstruct the latter, and produce spasmodic renal and ureteral pain. A coexisting hæmaturia or pyuria is then erroneously thought to have its origin at the seat of pain in the loin.

A judicious use of the sound and the cystoscope has done much to prevent the occurrence of this mistake, but quite recently a young man came under my care, suffering from pain in the right loin and along the course of the ureter; he also had some pyuria and slight hæmaturia and frequency of micturition. Six months earlier the right kidney had been explored, freely incised, and discovered to be large but healthy. With the cystoscope I discovered tuberculous ulceration especially around the right ureter.

6. Appendicitis may cause symptoms closely simulating those of

renal calculus, thus a distinguished surgeon considered himself to be the subject of frequent attacks of renal colic, until at last a swelling appeared over the appendix, which was removed; this relieved the symptoms.

In addition to the above, Morris alludes to having known cases of each of the following conditions give rise to symptoms simulating renal calculus:—malignant and tuberculous growths in the intestines, aortic, or cœliac aneurysm stretching the ureter or renal vessels, abscess and calculus in the prostate, ovaritis, and tuberculous disease of the Fallopian tube. Finally, I must mention the following exceptional case of *malignant disease involving the last dorsal nerve*, that came under my care seventeen years ago:

The patient, aged 44, came with hæmaturia, wearing pain, tenderness in the right loin and thigh, and oxaluria. His childhood had been passed in Norfolk, and as a lad he had been cut by Mr. Birkett for stone in the bladder. I sounded him twice, and finding no stone, I swept the sound in contact with the bladder in different directions, in the hope of detaching fragments of growth if one were present. No relief being given by drugs, I explored the right kidney, and could find nothing abnormal. Four days after the operation, when all seemed to be doing well, the patient died very suddenly. At the necropsy we found (*a*) a primary carcinomatous growth of the bladder of a somewhat unusual kind; it involved the apex as a flocculent, superficially ulcerated area; (*b*) a ring of secondary deposit surrounding the *right* last dorsal nerve, just at its exit from the spine; (*c*) a mass of enlarged glands around the inferior vena cava, and at one spot sprouting into it; (*d*) the *left* kidney contained a large branching calculus.

In some cases it may be difficult to decide which kidney to explore, hæmaturia being the main symptom, and pain being bilateral, indefinite or absent. The cystoscope or the segregator may then decide the point, if skiagraphy and other means have failed to do so.

Operation.—The patient being in much the same position as that for lumbar colotomy, on the sound side, with a firm pillow under the opposite flank, the surgeon defines carefully the lower border and length of the last rib. That this is not an unimportant detail in renal operations is proved by the following:

Prof. Dumreicher,* of Vienna, accidentally opened the pleural cavity during an attempt to remove a pyonephrotic, calculous kidney. At the necropsy it was found that the last rib was rudimentary, that the pleura projected a good deal below the lower edge of the eleventh rib, and that thus, when the incision was carried upwards, the accident had become unavoidable. Dr. Lange, of New York, has called attention to the investigations of Dr. Holl,† of Vienna, on the frequency of rudimentary development of the last rib, and the importance, therefore, of counting the ribs before intended operations on the kidney. Dr. Lange‡ himself shows that in some cases, which are, however, exceptional, even normal development of the twelfth rib may demand extreme caution, as the pleura may project considerably below it.§

* Quoted by Dr. Lange, *loc. supra cit.*

† Dr. Holl found that in quite a considerable percentage the last rib is so abnormally short that it does not reach as far as the outer border of the sacro-lumbalis, or so rudimentary that in some cases it more resembles a transverse process; and that in these cases the lower edge of the pleura passes from the lower boundary of the last dorsal vertebra almost horizontally towards the lower edge of the eleventh rib.

‡ *Ann. of Surg.*, vol. ii., Oct. 1885, p. 286.

§ In other cases the reverse condition may be present; though the last rib be rudimentary, the pleura may pass from the lower edge of the eleventh dorsal vertebra horizontally towards the eleventh rib, and thus be altogether out of danger.

The surgeon, having defined the length and position of the lowest rib, makes an oblique incision, at least 4 inches long, $\frac{1}{2}$ inch below it, and beginning about $2\frac{1}{2}$ inches from the spine. The skin and fasciæ being divided, the muscles—viz., anterior fibres of the latissimus dorsi, the external and internal oblique—are cut through, either on a director, or simply by light sweeps of the knife. As soon as the yellowish-white lumbar fascia is reached, any bleeding vessels, which have been temporarily secured by Spencer Wells's forceps, are tied or twisted. If the last dorsal nerve cross the incision, it, together with its accompanying vessels, should be drawn aside and left untouched if possible. The lumbar fascia is next slit up on a director. The perirenal fat, which now bulges into the wound, is torn through. With two large retractors opening up the wound, the surgeon continues to tear through the above fat* till he can see, or easily feel, the posterior surface of the kidney. Injury to the peritonæum (p. 178) is best avoided by keeping close to the outer edge of the quadratus lumborum. During this first stage of the operation the surgeon will find sometimes that the muscles are much thickened by reflex irritation from the presence of the stone, and, if the stone has been associated with suppuration and peri-renal inflammation, the tissues will be more or less densely blended and matted together.

An assistant now makes powerful pressure on the opposite side of the abdomen, so as to keep the kidney up into the wound, this being widely opened by full-sized retractors, aided, if needful, by an assistant pulling up the lower ribs with his hand. Thus the surgeon is enabled to examine the organ, which is done systematically: the finger is first directed to the pelvis, then to the posterior surface; next, by passing the finger round the outer border, to the anterior surface, which, as Sir Henry Howse has pointed out (*Clin. Soc. Trans.*, vol. xvi. p. 93), can be done effectually by pressing the kidney back against the firm, unyielding psoas. The sensation given by a stone has been compared to that of the uncut end of a pencil (Morris), or the last joint of a finger (Howse).

If the above means fail, the incision must be made sufficiently free, especially in a fat patient, and a deep loin, to expose the kidney more thoroughly. Additional room may be gained by converting the usual lumbar incision into a T-shaped one, or by making use of König's incision, in which the muscles are cut through as far as the rectus, and the peritonæum pushed forwards, or, as recommended by Morris, continuing the original incision downwards and forwards to a point one inch above and in front of the anterior superior iliac spine. Morris (*Surg. Diseases of Kidney*, vol. ii. pp. 185, 209), also sometimes removes the distal two or three inches of the twelfth rib, subperiosteally, after exposing its outer surface through a vertical incision carried upwards from the oblique one. He also incises the quadratus lumborum if the muscle is broad, and the ligament of Henle if obstructing the view. A small stone in the kidney will always be liable to be overlooked; but a surgeon does not give his patient or himself a fair chance who is content with exposing part of the kidney through a limited incision, and then trusting to punctures with a needle.

* If this fat is very abundant, some of it should be carefully torn away; poorly vitalised, it is prone to suppurate tediously and to delay healing, when the urine is septic.

Needling if negative is inconclusive; if positive, an incision into the kidney or pelvis becomes necessary, so that nothing is to be gained from this unsatisfactory and delaying procedure.

If the stone cannot be felt either in the pelvis or after palpation of the posterior and anterior surfaces of the kidney, this should be drawn up and out of the wound as far as possible, and again examined, a careful watch being kept upon the pulse.

When the kidney cannot be brought out on to the loin, the incision should be made large enough to see what is being done.

All the above, including palpation of the kidney between the finger and thumb, failing, the kidney itself or the pelvis* must be incised, and explored with a sound and the finger. During this part of the operation, hæmorrhage is prevented either by compressing the renal vessels between the left thumb and index finger, or, as advised by Cumston of Boston (*Ann. of Surg.*, vol. xxvi. p. 320), by means of a special clamp which he has devised for the purpose. Cumston finds that pressure may be kept up by this means as long as half an hour without harm resulting, the operation being accomplished without any loss of blood. Morris (*Surg. Diseases of the Kidney*, 1901, vol. ii. p. 187) makes a small cortical incision, which the exploring finger fills and even distends, thus controlling the bleeding to a great extent during the exploration. A free incision is made through the convex border of the kidney into the pelvis, and a thorough and systematic examination of each calyx carried out by means of the index finger or a short-beaked child's bladder-sound. The beak should be not more than a third of an inch in length, a stem of about seven inches, and the size of a No. 3 English catheter. The position of the calculus having been made out, it is removed, if small, through the incision in the convex border of the kidney. If this is inconvenient, or the stone large, an incision is made directly over it, and the stone then removed. It is quite immaterial whether this incision is made into the renal parenchyma or the pelvis, provided that it is sutured afterwards.

If the stone is irregularly branched, some laceration of the kidney tissue may be spared if the calculus is broken up and removed in two or more fragments. In this case the bed of the stone should be freely

* In the following case, under the care of Mr. T. Jones, of Manchester (*Med. Chron.*, June, 1887, p. 212), opening the pelvis alone sufficed to find the stone, after systematic exploration of the kidney had failed: "The forefinger was passed to the anterior surface, and the organ grasped between the finger and the thumb; nothing, however, could be found. The kidney was then carefully explored by systematic puncture with a long needle, also passed towards the pelvis, but no calculus could be felt. An incision, sufficiently large to admit the tip of the index finger, was then made through the kidney substance into the pelvis by means of a fine bistoury. On introducing the forefinger, a small stone was discovered firmly lodged in one of the superior calyces. Small, straight, lithotomy-forceps were introduced, and the stone thus removed." Very free hæmorrhage attended the above incision, but it yielded to pressure made with carbolised sponges, and kept up for five minutes. The patient made a good recovery. The calculus, consisting of lime oxalate, weighed twenty grains. This plan of opening the pelvis might be thought to cause a risk of leaving a urinary fistula, but the numerous cases in which calculi have been removed from the renal pelvis with entire success do not support this view. If the pelvis be dilated this spot should be chosen, otherwise I generally incise the convex border at its lower part, at a spot more readily kept under notice if much bleeding follow.

washed out with hot boracic acid lotion or Thompson's fluid,* so as to check oozing and remove all *débris*.† Mr. H. Morris (*Brit. Med. Journ.*, Nov. 16, 1889) thus alludes to two difficulties which these stones may cause:—"A large branched calculus may be so tightly embraced by the kidney substance, and the kidney may be so uniformly even on its surface, that nothing more than a very firm tough organ may be thought to be present, and even on passing a needle into it no sense of calculus, but rather the resistance of a tough fibroma, is met with. In these cases much difficulty will be experienced in freeing the stone from its encasement, and for this purpose the moderately free use of a bistoury will be requisite. It is astonishing how some of the large branches of a calculus may escape detection unless the surgeon is aware of the firmness with which they are embraced by the tough renal tissue. After removing several large pieces of calculus I have, in one or two cases, thought that all must have come away, because with my finger in the kidney nothing but renal tissue could be felt, and yet, after scratching through at some points where the resistance was greater than elsewhere, branch after branch of calculus has been exposed, showing that more of the calculus would have been left behind than had been removed had the operation been discontinued, because no further actual contact with the calculus was made with the finger in the interior of the kidney."

If the kidney be enlarged, with expanded calyces, the result of calculous hydronephrosis or pyonephrosis, on searching through the pelvis after a stone, the gush of fluid and collapse of the expanded kidney may cause the stone to disappear, and thus lead to much trouble in its removal (Symonds, *Clin. Soc. Trans.*, vol. xviii. p. 181).

Mr. Morris (*loc. supra cit.*) gives two other conditions which may prove embarrassing. "Sometimes in feeling over the kidney a portion of it, varying in size from a sixpence to a five-shilling piece or more, is found soft, flaccid, thin or fluctuating, and there is nowhere any sense of hardness or increased resistance, such as might be expected from even a phosphatic stone. On incising or puncturing this soft part, pus or purulent urine is drawn off, but no stone is felt; but on introducing the finger into the interior of such an organ, a small calculus may be detected, freely movable within an enlarged pelvis, or fixed in a dilated calyx, or possibly at the apex of a funnel-shaped pelvis. Such cases show that aspiration, or simple incision and drainage, are insufficient, and that one ought not to be satisfied with anything less than a digital examination of the interior of the pelvis, of the calyces and commencement of the ureter. Another arrangement of the calculus is sometimes found in sacculated kidneys. The renal cavity may be

* Water, 4 oz.; glycerine, 4 oz.; borax, 2 oz. To be diluted with water to 1 in 10, or 1 in 4, according to the condition of the part syringed. Solutions of carbolic acid or mercury perchloride should be avoided in such cases, for fear of irritation or absorption. The temperature of the fluid should be about 110°.

† Mr. Kendal Franks (*Lancet*, 1880, vol. ii. p. 1223) thus removed, piecemeal, a friable stone weighing 171 grains, and composed of lime carbonate and phosphates. In this case the urine had been fetid, though acid. The wound healed by first intention. In cases of piecemeal removal of calculi, especially when friable, a certain amount of doubt will often remain as to the entire removal.

wholly or partially filled by a soft, mortary, phosphatic calculus which gives no sound or resistance to the scalpel or trocar, and yet, on incising the renal substance and inserting the finger, a stone of considerable size may be felt."

One more difficulty, which must, however, I think, be a very rare one, is inability to reach the pelvis in a stout patient. Mr. Mansell Moullin relates (*Clin. Soc. Trans.*, vol. xxv. p. 57) a case of this kind :

The patient, a lady, aged about 40, and rather stout, had suffered for ten days from total suppression of urine, believed, and correctly so, to be due to a calculus having blocked the upper end of the ureter of the only kidney which remained functionally active. The left kidney was explored by the usual lumbar incision. "There was no difficulty in finding the kidney, although it seemed to lie unusually deep. Its surface was smooth and uniform, but very firm, and it was not possible, either by rolling the patient on to her back, or by hooking the kidney outwards, to pass the finger sufficiently far on to the anterior surface to feel the pelvis. The kidney was punctured and explored by dressing-forceps and sound, but no stone detected. The operation was successful in that urine soon began to escape, but the patient sank with pyelitis and increasing asthenia on the twenty-third day. The necropsy showed no trace of a right kidney. The left was much enlarged, and an oval uric-acid calculus was impacted in the ureter at its commencement, lying nearly in the middle line of the body.

If after free incision and thorough exploration of the kidney no stone is found, the ureter must next be explored throughout its whole length by passing a No. 3 English bougie or catheter down it into the bladder. Morris advises that this step be taken in all cases, whether a stone has been found in the kidney or not ; this is certainly a wise thing to do. Urine or injected coloured solution should be withdrawn by the catheter from the bladder ; the surgeon is then certain that the passage is clear. The catheter may be passed through the incision in the kidney into the ureter. If, however, the orifice of the ureter cannot be hit off in this way, Morris advises a small puncture in the posterior aspect of the infundibulum, through which the catheter can be more easily passed into the ureter. After the exploration this incision can be closed by a catgut suture.

Should a stone be found to be impacted in the ureter, it must now be exposed and removed. The following description of the methods of reaching the different parts of the ureter is chiefly based on the lines laid down by Morris :—The original oblique incision is prolonged downwards and forwards to a point one inch above and in front of the anterior superior iliac spine, and, if necessary, still further forwards towards Poupart's ligament, and then, parallel to this structure and one inch above it, as far as the level of the internal abdominal ring, or even farther. Through this incision both the abdominal and pelvic portions of the male ureter can be exposed, and the abdominal part and upper half of the pelvic portion in the female.

Since the ureter is frequently dilated behind a stone, after the calculus has been reached with the finger in the manner described, it can generally be gradually pushed up the dilated ureter towards the kidney. If possible this should be done, for two reasons : in the first place, the higher in the ureter the more accessible will this structure be for removal of the stone and suture ; and, secondly, damage to a portion of the ureter already probably inflamed or ulcerated by the calculus will be avoided, and thus more rapid healing ensured,

In order to remove the stone the ureter must be incised over it in a longitudinal direction with a sharp tenotome. The wound in the ureter is then immediately closed by means of Lembert sutures passing through the outer coats only, the number of sutures depending on the size of the incision in the ureter. Incisions made into the kidney can usually also be sutured. When, however, the kidney substance has been much lacerated in the removal of a large calculus, sutures are better dispensed with. For incisions into the infundibulum, Lembert sutures of fine catgut are employed. Incisions in the renal parenchyma may be closed in the following manner: Several sutures of medium-sized catgut are used (if too fine, they will cut through). They are passed deeply through the kidney by means of large, fully-curved needles, three to five sutures being used, according to the size of the incision.

These sutures are passed and tied before the compression of the renal vessels is relaxed, Cumston (*loc. supra cit.*) suturing the kidney before removal of the clamp. In this way two very important advantages are gained—the prevention of hæmorrhage from the kidney, and also usually the prevention of leakage of urine; the result is that primary union of the incisions generally takes place, and rapid healing of the whole wound and early convalescence thus ensured.

A drainage-tube or a strip of iodoform gauze is now passed down to the kidney or the incision in the ureter, in order to allow of free drainage should leakage of urine occur. The rest of the wound is then closed, the muscles being first brought together by buried sutures.

If, however, the kidney has been much lacerated, or if for any other reason no sutures are placed in the kidney, a full-sized drainage-tube must be passed down to the kidney in order to allow of free drainage; or if there is free oozing the wound may be packed with iodoform gauze, which is left in position for twenty-four hours. The ends only of the wound must be sutured in this case, and the dressings changed as often as they become soaked with urine.

A stone may be missed at the operation, and come away from the wound, or be passed later on *per urethram*. An instance of the former is given by Mr. Bruce Clarke (*Illus. Med. News*, p. 4). The latter happened to me in case No. 9 in the table (p. 188).

After-treatment.

The chief points here are: 1. The meeting of shock after a prolonged operation. 2. The patient's attitude in bed should be recumbent but with pillows placed behind the shoulder and ileum of the affected side; pressure on the wound is thus avoided. Later the patient may be propped up for the better drainage along the ureter. 3. Changing of the dressing at sufficiently frequent intervals at first, if any urine or blood or both soak through. 4. Removal of the tube on the third or fourth day unless discharge continues, when the tube should be gradually shortened; this is likely to be necessary where there has been much interference with the surrounding parts or where pus has been present in the kidney. 5. Rectal feeding until vomiting has ceased, but water, coffee or tea can be given by the mouth from the first to allay thirst, moisten the mouth, and promote urinary secretion.

6. Care must be taken to relieve the bladder by passing a catheter if necessary. If suppression occurs, saline injections into the rectum or subcutaneous tissues are indicated. Subcutaneous injection of pilocarpine may also be tried.

Lastly, it may be pointed out that the life-histories of these cases should be followed up most carefully, to see how far the cure remains a complete one; to aid this, the patient should pay lifelong attention to his diet, habits, exercise, &c.

Difficulties in Nephro-lithotomy.

1. An insufficient incision and a narrow ileo-costal space. 2. Abundant fat—*e.g.*, in the subcutaneous tissues, around the kidney, and extra-peritonæal, rendering the wound very deep. 3. Rigidity, and perhaps thickening, of the muscles, due to the irritation of the stone. This condition was present in a very marked degree in a patient from whom I removed the smaller calcium-oxalate calculus (Fig. 63). No amount of anæsthetic seemed to have any effect on this condition. Fortunately the loin was a thin one, and the stone very obvious on reaching the pelvis. 4. Matting of the parts around the kidney, rendering it difficult to explore this organ, its different parts and relations, exactly. 5. An indurated condition of the kidney itself from the irritation of a stone. 6. Troublesome flatulent distension of the colon. This is not at all uncommon. The bowel should be packed away with sponges fastened on to silk, and pushed deeply into the front of the wound. 7. Opening the peritonæum. This accident occasionally occurs in difficult cases. If the wound be kept aseptic, there will be no serious consequences.

In case 11 of the series below, I opened the peritonæum under the following circumstances: The week before, in No. 10, the kidney lay very high up under the ribs. In No. 11 it was placed very low, closely surrounded by the colon, and with its lower end in the left iliac fossa. It was also the seat of a small hydronephrosis, and therefore soft and yielding. On slitting up the lumbar fascia the descending colon came into view with a soft mass behind it, which I took for pultaceous fecal contents. I accordingly explored with my finger higher up, and under the ribs found a body firm and fleshy, with a feel like the kidney, but too small. This proved to be the spleen, unusually movable. The opening in the peritonæum was kept covered by aseptic sponges, and the mass behind the colon investigated. This proved to be the kidney, extremely low down, and containing a calculus in the pelvis, this last being also distended with fluid. For the first few days I kept strips of sal alembroth gauze, changed two or three times in the twenty-four hours, tucked up under the ribs, and stitched the low-lying kidney well up into the wound, so that the urine should escape freely. The patient recovered without a bad symptom. Smaller openings should be tied up with chromic gut, or sutured with the same.

8. A stone present, but very difficult to detect. This may be due to (a) its small size, especially if it lies deeply in a calyx, or is surrounded by very indurated kidney tissue. A very small stone may cause severe symptoms. This was proved by some of the cases in the table given at p. 188.

Thus, in Case 5, a stone, weighing but fourteen grains, and situated in the top of the ureter, quite incapacitated the patient from any work. In case No. 8, another very small stone, firmly fixed in a calyx at the upper part of the kidney, caused severe hæmaturia and pain.

The following case, under the care of Dr. Murphy, of Sunderland (*Brit. Med. Journ.*, vol. i. 1891, p. 757), shows still more clearly what urgent symptoms a tiny calculus may cause :

The patient, aged 39, had been a complete invalid for nine months, owing to repeated attacks of renal colic, which morphine failed to relieve, the administration of chloroform being frequently required. At the operation, "a very small stone, about the size of a hemp-seed, escaped with a flush of blood," when the kidney was incised. The site of the stone is not given. A good recovery followed.

How impossible it is to detect some stones, without incision of the kidney, is shown by a case published by Mr. Morris : *

This authority, with all his experience, after thoroughly exploring the kidney, compressing it all over with the finger and thumb, and also after puncturing it, failed to detect a stone which lay in a hollowed-out calyx. Though the calculus was the size of a small marble, it was so thickly surrounded by kidney-tissue that, even after the removal of the kidney, the position of the stone could not be detected by pressing on the kidney with the fingers as it lay on a table. The patient made a good recovery.

(β) A sacculated kidney, into one of the sacculi of which a small stone may fall and be hard to find (p. 175).

9. A stone on the anterior surface of the kidney, especially if near the entrance of the vessels. 10. A very large or a branching stone (p. 175). Mere size does not necessarily create difficulties in extraction, though, owing to the changes entailed in the kidneys, the general health, &c., by the long duration of a calculus, the prognosis is rendered very much less favourable. Thus, in the calculus (Fig. 63) weighing 473 grains, or very nearly an ounce, the very bulk of the stone rendered its detection easy; it was readily loosened from the much dilated pelvis with lithotomy forceps. A branched calculus presents, of course, much greater difficulties (p. 175).

Mr. Bennett May has published (*Clin. Soc. Trans.*, vol. xvi. p. 90) an excellent instance of this kind, in which he successfully removed a very large, somewhat S-shaped calculus from a man aged 34, with symptoms of sixteen years' duration. Though the stone weighed 473 grains, and was three inches long, manipulation failed to make it out distinctly, but acupuncture detected it at once.

Mr. Footner, of Tunbridge Wells, removed a calculus weighing 822 grains, or nearly two ounces. The patient made a good recovery, but a sinus persisted, through which, on two occasions, a millet-seed calculus was passed (*Brit. Med. Journ.*, 1892, vol. ii. p. 69). A calculus far exceeding the above was brought by Mr. D. Day, of Norwich, before the Clinical Society (*Trans.*, vol. xxvi. p. 24). This calculus, mainly phosphatic, weighed 1331 grains. The patient made a good recovery, with a sinus persisting in the loin. A calculus larger than either of these is mentioned at p. 184.

11. A stone which breaks up rapidly (p. 175). Another condition allied in difficulty is where a calculous deposit rather than a distinct calculus is present. This is more grave, as the deposit here will usually be phosphatic, and point to co-existing pyo-nephrosis. 12. Multiple calculi. Stones (usually minute in size) numbering over 60 or 100, have been removed on several occasions. In such cases

* *Med. Chir. Trans.*, vol. xlvi. p. 69. The woodcut (p. 73) shows well the relation of the stone to the surrounding kidney.

it is always possible that the minute calculi have been retained, owing to a larger calculus—*e.g.*, in the pelvis or ureter—blocking their exit. 13. A very mobile kidney. The importance of having an assistant to push the kidney well up into the wound has already been insisted on. It is essential to have this done both for detection of the stone and for its removal, in order to avoid needless disturbance of the surrounding parts, or the kidney may be secured with sutures at the commencement.

• Mr. May (*loc. supra cit.*) explains the remarkable fact that his large stone was not felt when the kidney was thoroughly exposed, by the fact that the organ fell forwards and thus embarrassingly increased the depth of the wound.

14. A kidney situated very high up under the ribs (p. 178), especially if there be firm adhesions around it. In such a case, it may be necessary to remove the distal two-thirds of the last rib, care being taken to preserve the pleura. 15. A kidney, the pelvis of which it is difficult to reach owing to the stoutness of the patient, as in the case given at p. 176.

Question of Nephrectomy during a Nephro-lithotomy.—In several of the above conditions the question of the advisability of removal of the kidney will arise—*e.g.*, where the kidney has been much handled and repeatedly incised, where the stone is large and branched and difficult of removal, where many stones are present, or where one is present and very friable, where the kidney is much altered by pyo- or hydro-nephrosis, and, finally, where the surgeon is certain a stone exists but cannot find it, as in Mr. Morris's case already alluded to at p. 179.

In such cases the surgeon will be guided by the age of the patient; the knowledge he possesses as to the condition of the other kidney (the amount of urine, &c.); the proportion of the urea excreted by each kidney, the evidence of skiagraphy of the opposite kidney, &c., the degree to which the kidney he is operating on has been disturbed from its relations, and its structure interfered with; the amount of disease, *e.g.*, number of sacculi, condition of pus contained in them, the thinning of the cortex, &c. When the surgeon is certain, from the history and failure of previous treatment, that a stone exists which cannot be found, he must be chiefly guided by the degree to which life has been made miserable. Finally, the length of time that the operation of nephro-lithotomy has already lasted, and the condition of the patient, must be taken into account. Where the patient is young, where the other kidney is healthy, where the kidney operated on is much damaged either by previous disease or by manipulation added to disease, where several stones are present, nephrectomy, either now, or a little later, is indicated; of these, immediate removal of the kidney is preferable if the patient's condition admits of it.* But the question is a very different

* An instructive case which was under my care illustrates well many of the above difficulties—viz., multiple and large calculi, a mobile kidney, the question of nephrectomy arising during nephro-lithotomy, and the formation of multiple calculi in one kidney without symptoms. In February, 1888, I was asked by Dr. Goodhart to see a case of probable renal calculus. The boy, aged 15, had been admitted with abdominal pain and grating of an indistinct and delicate nature in the left renal region. This kidney was slightly enlarged. When asked to localise his pain, the patient pointed to the region of

one where the kidney is a large one after its fluid contents as well as a stone have been removed; or where it is a case of multiple calculi in a suppurating, damaged kidney. Nephrectomy should, as a rule, be deferred here, and the kidney thoroughly drained, for (1) additional shock and loss of blood will be avoided. (2) The condition of the opposite kidney, very possibly calculous also, will be made clearer by waiting. (3) The bulk of the kidney will be lessened by drainage. (4) Though a source of discomfort (if an open sinus persist) it may still do some and important work.

Causes of Death after Nephro-lithotomy.—Very few unsuccessful cases have been published; the following appear to be most probable causes of after-trouble:

1. **Hæmorrhage.** A most interesting case of hæmorrhage, fatal on the seventh day after nephro-lithotomy, was brought before the Clinical Society (*Trans*, vol. xxii. p. 214), by Dr. Stevenson and Mr. Butler Smythe:

Several small and one larger stone (this one being tightly fixed in the pelvis and ureter) having been removed from a kidney, the site of hydro-nephrosis, the patient did well, save for a temperature which was 103° on the third and fifth days and all along very variable, until the sixth day, when bright blood and urine were passed both by the urethra and by the wound. On the seventh day about half a pint of bright bloody urine was drawn off from the bladder, and death took place soon after, with symptoms of internal hæmorrhage. The kidney was found enormously distended with blood-clot and bloody urine. The opening made at the operation was small and blocked up by clot. Embedded in the kidney substance,

the *left* kidney and the *left* loin. This kidney being explored was found to be occupied by irregular nodulated masses. A hare-lip pin at once came on and between calculi. The kidney being incised, hosts of calculi, comparable only to a gravel-pit, were found in the calyces and pelvis, the chief nests being at the upper and lower extremities. The former of these, lying as they did high up under the ribs, gave much trouble. To get at them the kidney-tissue was again scraped through directly over them, and many of them thus reached. The chief difficulty of the operation, in addition to the number of stones, was the great mobility of the kidney, though this organ was well pushed up from the front. The condition was perhaps due to the almost entire absence of surrounding fat. When I realised the condition of the kidney, I expressed myself in favour of nephrectomy, as the organ was almost useless, as the stones were so numerous, and as a prolonged attempt at removal would produce more shock in so weakly a subject. One or two less important points in favour of nephrectomy were the mobility of the kidney and the entire absence of adhesions. Dr. Goodhart's counsel was, however, against this step, owing to the small percentage of urea—this had never been above 1·2 per cent., and often less. I accordingly continued; when forty-six calculi had been removed and the operation had lasted three-quarters of an hour, the pulse failed so ominously that I was obliged to desist. Very little blood escaped as long as the opening was plugged with the finger, but considerable oozing followed as the finger brought out the stones. The patient never rallied well, and died three hours and a half after the operation. The necropsy showed a little ecchymosis around the left kidney; this still contained calculi at its upper and lower parts. The *right* kidney, of which the boy had never complained, also contained a large number of stones. Its substance, though much wasted, still contained a fair amount of secreting substance. The condition of the opposite kidney thus abundantly justified my old friend's opinion. Feeling that unsuccessful cases of nephro-lithotomy have not been sufficiently published, I brought this and the case at page 182 before the Clinical Society. A detailed account of each will be found, with ten others, in the *Transactions*, vols. xxii. p. 198, and xxiv. p. 155.

close to the pelvis, was a round spiked calculus, which had ulcerated into a branch of the renal artery just at its entrance into the kidney, and had given rise to profuse bleeding into this dilated organ.

2. Shock. This may be lessened by wrapping up the limbs in gamgee tissue before an operation which is expected to be difficult and tedious. It may be combated by saline infusion and injections of adrenalin, strychnine or aseptic ergot.

The following possible causes of hæmorrhage after nephro-lithotomy must also be remembered :

In case No. 19 in the table, p. 189, the patient was a young Welsh miner, with all the symptoms of renal calculus well marked. At the operation two calculi were easily found and removed from the lower part of the right kidney. About three hours after the operation the usual soakage of urine had taken place through the dressings; but it was noticed to be unusually brightly stained with blood. When the dressings were removed blood was seen to be trickling through the tube which I had left in contact with the wound made in the lower part of the outer border of the kidney. Dr. Bligh, now of Caterham Valley, and then house-surgeon, plugged the wound, and, the patient passing into a state of collapse, resorted to saline infusion. On my arrival at this time, I found that the patient had partially rallied. Similar bleeding followed about two hours later, the wound was replugged, and transfusion again resorted to; but the patient sank seventeen hours after the operation. At the necropsy nothing was found in the wound beyond some coagula and ecchymosis round the kidney, and a very small calculus, which I had overlooked when the two others were removed. There was marked contraction of the mitral valve. It is very difficult to estimate the loss of blood in such a case, but it was thought not to exceed six or seven ounces, and there were no coagula. The operation was of the simplest kind, but the marked pallor of the patient's face ought to have led me to inquire for a cause beyond that which I too readily took for granted, viz., the pain, &c., set up by the renal calculi. I am not aware of any case that has been published in which surgical hæmorrhage has been associated with a contracted mitral valve, but I have been given to understand that parturient women with the above lesion are especially liable to the peril of flooding.

Another possible cause of hæmorrhage after nephro-lithotomy is where calculi are associated with a growth in the pelvis of the kidney. Mr. Battle has recorded a most interesting instance of this (*Brit. Med. Journ.*, vol. i. 1895, p. 1206) :

At a lumbar nephro-lithotomy several oxalate calculi were removed and a villous growth scraped away from the lower anterior aspect of the pelvis. The patient resumed work, but the hæmaturia returned and became profuse and constant, and the kidney was removed about eighteen months after the first operation. The surface about the pelvis was papillated and firm, and the microscope showed evidence of a new growth at this spot, but whether this was a simple papilloma or a squamous epithelioma remained doubtful.

Hæmorrhage may be treated by tightly packing the wound and applying firm pressure. Nephrectomy may have to be done in a few cases.

3. Cellulitis. If it has been needful to incise or tear the kidney freely, if the urine is foul, and the bleeding has been arrested with difficulty after imperfect and repeated plugging, this may be readily brought on. Other causes of this will be found in much disturbance of the wound or fingering by many hands.

4. Uræmia, if the other kidney is the site of calculous disease or

disorganised. This was chiefly the cause of death in the case in which I removed the large stone (Fig. 63).

The patient was a solicitor, aged 58, of sedentary life, and gouty history, who had suffered from attacks of right renal colic off and on for upwards of thirty years,* these attacks having become increasingly fierce for about six months. Occasionally he had had slight pain on the left side, and on the morning fixed for the operation he passed two small, fawn-coloured calculi of lithic acid and lithates. These were quite insufficient to account for all his suffering, and as prolonged and careful treatment had entirely failed, and as his "life was not worth having at the price," the operation was proceeded with, and the huge renal calculus figured removed. This was effected with the utmost ease, as the stone, from its size and hardness, was readily detected occupying the distended pelvis of the kidney. A profuse jet of venous blood followed its removal with lithotomy forceps, after it had been loosened by a scooping movement of the finger. The hæmorrhage was at once arrested by sponge-pressure kept up for a few minutes. All went well for the first week, save for persistent oxaluria, which no treatment could remove. The patient was able to sit up and read; appetite returned, and the wound was healing well. On the sixth day a change for the worse set in, first much flatulence and nausea, then constant restlessness, followed by coma, ending in death on the morning of the eighth day. I cannot doubt that the opposite kidney was here also the seat of stone, and its tissue too much impaired to admit of recovery, though I was unable to obtain a post-mortem examination to verify this. I should add that the urine in this patient before the operation was acid, of sp. gr. 1018, and without sugar or albumen. The quantity passed was natural, and the urea sometimes normal, sometimes slightly deficient.

FIG. 63.



The larger calculus is the one mentioned here in the text. It weighed 473 gr., and consisted of lithic acid and lithates. The main mass lay in the dilated pelvis, the processes fitted into the calyces. The smaller calculus, composed chiefly of oxalates, was successfully removed from a patient aged 24. It weighed 42 grs. The two are good instances of what nephro-lithotomy can, and what it cannot do, without grave risks.

Dr. Whipham and Mr. Haward (*Clin. Soc. Trans.*, vol. xv. p. 123) have recorded a case which, with my own just given, points urgently to the importance of surgeons being permitted to explore earlier:

The patient, aged 56, had for "several years" been troubled with "gravel." The symptoms here were chiefly indicative of calculous mischief in the left kidney, but there was some tenderness on the right side as well. The urine here was 1006 sp. gr., alkaline, and contained pus. The left kidney was explored, and found in a state of pyo-nephrosis; no calculus was found, but a copious discharge of pus took place soon afterwards, giving great relief. The patient a little later again lost ground, and the wound was thoroughly

* This long duration of symptoms was unfavourable. Mr. Keetley was more fortunate in a case equally long standing, in a much younger patient (*Brit. Med. Journ.*, vol. i. 1890, p. 134). A gentleman, aged 44, for thirty years had not passed twenty-four consecutive hours without pain. Mr. Keetley removed 150 calculi from the right kidney. A large rough calculus had blocked the way into the ureter for the numerous smooth calculi which formed behind it. The patient made a good recovery.

explored a second time, but the patient sank a few hours after this, a month after the first operation. The left kidney-pelvis was much dilated in its upper part, and communicated with a large peri-nephritic abscess. The right kidney contained a large branching calculus.

Modern methods of examination will do much to diminish the number of deaths from uræmia, by enabling the surgeon to press and the patient to accept operation earlier, and by preventing the surgeon from operating on unsuitable cases with deficient functional capacity of the other kidney.

5. Septicæmia. This condition may be induced by the wound becoming foul, a complication which can always be prevented after removal of small stones from healthy kidneys. But where pyo-nephrosis exists, it may be impossible to keep the wound sweet from the first. This was so in Case 6 of the subjoined table.

Here, after removal of nine calculi, I was obliged to remove the kidney a year later, owing to the persistence of a fœtid sinus.

And it is to be noted that septicæmia may occur after a nephro-lithotomy, successful as far as the removal of the stone goes, after a considerable interval, where pyo-nephrosis coexists. This is an additional reason for carefully considering the advisability of performing nephrectomy in such cases.

Dr. Shepherd, of Montreal, has published* a very interesting instance of this kind:

Nephro-lithotomy was performed in a patient aged 26, who had suffered from symptoms of stone for seven years, with no tumour, and pus in the urine. An enormous, unbreakable stone of triple phosphate was removed with much difficulty from the left kidney. It weighed 4 oz. 7 dr., and measured $3\frac{1}{2}$ inches in length and 9 inches in circumference. The tissue of the lower part of the kidney exposed seemed healthy, and no pus being evacuated it was thought best not to remove the organ. The wound continued to discharge pus, and the temperature varied correspondingly for three months and a half after the operation, when septicæmia set in and proved fatal. The necropsy showed that the upper part of the kidney, which was not exposed, consisted of large communicating sacs, containing over 10 oz. of fetid-pus, and a number of irregular branched calculi. Dr. Shepherd points out that the fatal septicæmia was undoubtedly due to these abscesses, showing the need of thorough exploration in all cases where a large stone has set up grave changes, and of extirpation in most of them.

I have described lumbar nephro-lithotomy fully because I believe that, on the whole, it is much the safer operation for the great majority of operators. But, to make the account complete, reference must be made to the proposal that **abdominal** should replace lumbar **nephro-lithotomy**.

As might be expected, this proposal has come from a specialist in abdominal surgery. Mr. K. Thornton (*Harveian Lectures*, "Surgery of the Kidneys," p. 34) gives the following reasons for preferring his combined method: "Recognising the difficulty in the diagnosis of a stone, and the still further complication introduced by the transference of pain in some cases to the opposite side, and the importance of being able to examine the other kidney and both ureters thoroughly,

* *Philadelphia News*, April 23, 1887; *Ann. of Surg.*, vol. vi., August 1887, p. 185. The right kidney is stated to have been perfectly healthy, but double its normal size.

throughout their whole course, I proposed to open the abdomen by Langenbüch's incision over the suspected kidney, examine carefully both kidneys and ureters, and, having found a stone, to employ one hand in the peritonæum to fix the kidney and stone, and guard the colon, while with the other I could cut down upon the stone directly from the loin, merely making an opening through the loin tissues large enough to introduce the finger and necessary forceps for the extraction of the stone." And again, at p. 36: "We are certain that the patient has the usual allowance of kidneys. The chances of overlooking the stone, if there is one present in either kidney, is reduced to a minimum. I do not say that the abdominal handling is absolutely infallible, but in fourteen operations I have only once failed to find a stone, and the recovery and present health of this one patient make it highly improbable that there was, or is, a stone in her kidney. This result compares very favourably with the large number of unsuccessful lumbar explorations already recorded."

No one who has seen much of lumbar nephro-lithotomy would allow the above remarks to pass uncriticised.

While I am fully aware of the difficulties in determining whether a stone is present, and in what part of the kidney it lies, I am convinced that every year that goes by will perfect our power of diagnosis, by making clearer to us the conditions that simulate stone. "The large number of unsuccessful lumbar explorations" of which Mr. Thornton makes a strong point is not quite correctly referred to by him. He implies that a stone was there, but that operators making use of lumbar nephro-lithotomy failed to find it. Now this is not quite the case. In the great majority of cases no stone was present. They were cases in which the diagnosis was at fault. It has always been so with every new operation, and is one of those faults which time alone puts straight. In reality, these failures to find a stone are rather creditable to the lumbar operation. The operators have been of the most varying degrees of experience, and the great majority of their cases* have recovered. Would this have been the case if the explorations had been through the peritonæal cavity with "the necessary manipulations to examine the kidneys and ureters"? Now, on this hangs one of my chief points. No one who knows anything of what Mr. Thornton has done for abdominal surgery will doubt for a moment that operations on the kidney through the peritonæum are certain to be as safe in his hands as any such operation can be. But what this book has to try and teach is what operation is the safest for the largest number of operators. I cannot agree with Mr. Thornton that the increased risk due to the opening of the peritonæum is practically *nil*—i.e., if the surgeon will take the pains to perform a thoroughly aseptic operation. I should agree that the risk of peritonitis is now much smaller than it was, but there are other risks which are inseparable from this mode of exploring the kidney.† I refer to the shock which the necessary manipulations of

* I have pointed out (p. 181) that there is reason to fear that fatal cases have not been published. But this would not apply to the lumbar operation only.

† Every one who has seen much of renal surgery will know that grave shocks may readily be met with in some of these explorations of the kidney. Thus, in the case of

certain very vital parts must entail. Mr. Thornton will be able to go straight to the kidneys with a minimum of disturbance of the overlying parts. But is it to be believed for a moment that this would be the case with the majority of operators? And this brings me to another point. Others who have tried this method have not found it so easy to detect the presence of a renal calculus or to determine the condition of the kidneys. With regard to the latter point, I may mention the following :

A woman was sent to me with long-standing pyuria of renal origin. She was clearly very near her end from kidney failure, and during the five days she lived no operation was admissible. After her death I thought it a good opportunity to investigate the condition of the kidneys by an abdominal incision. I was able to feel that there was a right kidney, which felt so hard that I thought it contained a stone. About the condition of the left kidney I was quite unable to satisfy myself. The necropsy showed that the right kidney was in a condition of fibroid atrophy; no stone was present. The left was a thin-walled sac containing pus. Owing to the great tenderness on this side, I had looked on this kidney as the source of the pyuria. It would have been readily reached from the loin.

I have only once tried to detect a renal calculus through an abdominal incision.

The case was No. 21 in the table at p. 189. As, in addition to the renal symptoms, there was trouble indicating oöphorectomy, I took the occasion, after Dr. Galabin had removed the ovaries, to explore the left kidney, where the presence of a stone was suspected. The existence of a calculus, which felt a large one—in reality, three were present—and of a small hydro-nephrosis could be made out, conditions which were verified at the time of the nephro-lithotomy a little later.

In this case the kidney was not enlarged, of the ordinary firm consistence, save near the pelvis, and free from the results of past inflammation. In such cases as these it will always be easy to detect the presence of the stone, but it will be very different in those cases where the stone lies in an enlarged kidney, the seat of a collection of fluid, or in one matted down with much thickening of surrounding tissues from long-standing inflammation.

But I would rather quote the opinions of others. Mr. T. Smith (Discussion at the Clinical Society, *Brit. Med. Journ.*, 1887, vol. i. p. 393) said that Mr. Thornton had seemed to represent that by opening the abdomen from the front one could ascertain with certainty whether there was a stone in the one or other kidney. But one could not always tell this even if one felt the kidney out of the body. In three different cases in which he had handled kidneys so removed no stone could be detected therein until the kidneys were cut open.* Another very interesting case, brought by Mr. Page before the Medico-Chirurgical Society (*Brit. Med. Journ.*, 1888, vol. i. p. 795) shows what

nephro-lithotomy (No. 12 in the table, p. 188) in a lady of 40, with fifteen years' history, from whom I removed three cystine calculi, the patient was so anæmic and unhealthy from her long-continued pain and marred life, that she nearly succumbed during the operation. Yet this was of the simplest, the loin thin, the calculi (387 gr.) found at once and extracted easily, the operation itself not exceeding twelve minutes. A.C.E. followed by ether had been given, but the pulse, always weak, became almost imperceptible after the first incision.

* On this point see Mr. Morris's case, p. 179.

care is needed when abdominal exploration for the examination of the kidneys is made use of.

Mr. Page thought that in this case abdominal exploration, had he made it, would probably have led him astray, as the left kidney, which, though small, was the working one, would have been removed, while the right viscus, which was really the seat of pyelitis and contained some small stones, would have been looked upon as merely enlarged to do the work of two, this increase in size being really due to its diseased condition.

Mr. K. Thornton (p. 37) mentions a case in which it took an hour to find the kidney by the lumbar incision, and which ended fatally, and another in which the surgeon failed entirely to find the kidney by the same method. Such cases, as shown by their number, are quite exceptional. When the large number of explorations of the kidney by the lumbar method is considered, it will be acknowledged that the lumbar method is characterised by the ease with which the kidney is found, and the well-doing of the cases afterwards, especially when the great number and the diversity of operators are considered.

With regard to pain in one loin due to mischief in the opposite kidney, we have very little knowledge as to sympathy between the kidneys. But this condition is certainly rare. As a rule, in renal calculus, pain is alone complained of on the side in which the stone lies. Pain in both loins means usually stones or disease on both sides, a far graver thing than "sympathy."

Mr. Thornton, in his combined method, which I have described at p. 185, lays stress upon the small clean cut which is made upon the stone by the loin, only large enough to introduce the finger and forceps. It is difficult to see how such an opening would suffice to remove a small stone lying in a calyx on the anterior surface of the kidney, one of the most difficult of all cases. By the lumbar operation the surgeon will be able, after freeing the kidney, as is nearly always feasible, to bring it out of the wound on to the loin, and carefully handle the anterior as well as the posterior surface, and if necessary he can incise the organ freely and examine the cavity of the pelvis with the finger. Only after such a thorough exploration can it be concluded that a stone is absent. With regard to the risk of the hernia which Mr. Thornton states (*loc. supra cit.*) to be "a not uncommon result of the lumbar operation," the experience of most surgeons will be quite the opposite. As already stated (p. 127), the tissues in the lumbar region are so strong and unyielding, compared with those in the anterior abdominal wall, that a protrusion does not readily take place here. Time and experience have amply proved the wisdom and moderation of these criticisms, which were made some years ago. The introduction of the Röntgen-rays, the cystoscope, and the segregator, has given us far better means of determining the presence or absence of a stone, and the condition of the other kidney, than a laparotomy can allow. It is not surprising, therefore, that the combined method advocated by Mr. Thornton and others has fallen into deserved disuse, and is now of little more than historical interest.

TWENTY-ONE CASES OF LUMBAR NEPHRO-LITHOTOMY.

No.	Medical Men.	Age.	Sex.	Site of Stone.	Weight.	No.	Result and Remarks.
1	Dr. Hale White.	23	M.	Pelvis.	grs.	1	Recovery.
2	Dr. Wilson, Haver- fordwest.	58	"	"	42 473	1	Almost certainly calculi in opposite kidney. Death ninth day. Opposite kidney a "gravel-pit."
3	Dr. Goodhart.	15	"	Throughout kidney.	652	46	Death three hours after.
4	For Mr. Durham.*	41	"	Pelvis.	78	1	Recovery.
5	Dr. Phillips, Faver- sham.	53	"	Top of ureter.	14	1	Recovery.
6	Dr. G. Newton Pitt.	31	"	Throughout kidney.	333	8	Recovery with a sinus. Nephrectomy a year later. Recovery.
7	Dr. Todd, Brigg.	29	F.	"	39	9	Recovery.
8	Dr. Cressy, Walling- ton.	22	M.	Calyx at upper part of kidney.	22	1	Recovery.
9	Dr. Morley, R.N., Chatham.	40	"	?	—	2	I missed both these stones after free incision of the kidney (in two places) and sounding. Both descended a little later. One was passed, the other I crushed. The patient has been perfectly well since. Recovery.
10	Dr. H. P. Berry, Grantham.	33	"	Pelvis.	45	—	Recovery.
11	Drs. Fry and Clay- ton Jones, Shep- ton Mallet.	28	"	"	49	—	Recovery.
12	Dr. L. Stephens, Emsworth.	40	F.	"	387 Cystine.	4	Recovery. The first and, I believe, the only cystine calculus thus removed.
13	Dr. Pye-Smith.	41	"	Pelvis and kidney.	1 oz. 2 gr.	—	Recovery. This patient was admitted with a perinephritic abscess, which I opened. I failed to detect the calculus at this time and removed it about three weeks later.
14	Dr. G. Newton Pitt.	14	M.	Pelvis.	118	1	Recovery.
15	Dr. Morley, R.N., F.R.C.S.	30	"	"	1 Oxalate.	1	Recovery. This was the most difficult case of all. The loin was very deep, the kidney lay very high up, and as I tried to draw it down, it began to tear trans- versely near the junction of the lower end and the pelvis. Thus the stone, never seen, was removed by the finger. Free bleeding recurred at first few dressings. Pyrexia, puzzling after operation, was attributed by Dr. Dowson (R.N.) to West African fever.

* This case had been admitted under Mr. Durham, and I operated during his illness. It afterwards transpired that the case had been sent up to Mr. Lucas.

TWENTY-ONE CASES OF LUMBAR NEPHRO-LITHOTOMY—(continued).

No.	Medical Men.	Age.	Sex.	Site of Stone.	Weight.	No.	Result and Remarks.
16	None.	23	M.	A calyx.	gtrs. 13	1	Recovery. This calculus was anomalous in site and structure. It was readily detected on the surface by a needle, and, as the kidney felt very hard, I expected a branching calculus. On cutting down on the spot where the grating had been detected I found a very small calculus. This was black in colour, readily crumbling under pressure, and chiefly composed of bloodclot and lime oxalate crystals. During the three years which have followed the operation the patient has had two attacks of colic on the same side. These were much milder than those preceding the operation, and he has been able to continue at his work, but I am inclined to look upon this recovery as probably incomplete.
17	Dr. Pochin, of the Old Kent Road.	32	F.	Pelvis and kidney. Pyonephrosis.	—	7	Recovery with a sinus. The kidney here was so diseased that nephrectomy was advised, but deferred by the patient. She has not been heard of since.
18	Dr. S. Sunderland.	42	"	Pelvis and kidney. Pyonephrosis.	—	3	Recovery. When seen two years later there was still pus in the urine. As the disease had lasted over twenty years, it is probable that both kidneys were affected. The scar was quite sound, and no enlargement of either kidney was to be detected.
19	Dr. Naunton Davies, of Pont-y-pridd.	35	M.	Cortex.	94	1	Death. A needle detected a small stone in the lower end of the kidney. Incision in the convex border. Venous bleeding somewhat free, but arrested by pressure. No plugging thought needless. Hæmorrhage through dressings (no clots), with rapid collapse about three hours after operation. Saline transfusion to four and a half pints, and wound plugged. Rallying of patient. Recurrence of hæmorrhage four hours later. The necropsy showed contraction of the mitral valve, p. 182.
20	Dr. Sutton Sams and Mr. Allworth.	34	F.	Top of ureter.	45	1	Recovery. The kidney, being very movable, was fixed by the method given at p. 225. I saw this patient a year and a half afterwards, and the kidney could be felt fixed in the loin. There has been no return of her trouble.
21*	Dr. Galabin.	42	"	Pelvis and ureter. Pyonephrosis.	48	3	Recovery. The chief trouble here was pyrexia and frequent micturition. Dr. Galabin having occasion to perform oöphorectomy, I had the opportunity of examining the kidneys. The dilatation of the pelvis and the presence of the stones were easily detected on the left side. The right kidney appeared healthy. A sinus persisted for some months and then closed firmly. When last seen the patient, instead of being a neurotic, exacting, bed-ridden invalid, was in good health.

* Nos. 2, 7, 8, 12, 15, 20, and 21 were private cases.

I was responsible for the after-treatment of all except No. 7.

THE TREATMENT OF CALCULOUS ANURIA.

Although spontaneous recovery from this very grave condition may occasionally occur, it is certain that an early and suitable operation is by far the best treatment. Morris (*Surg. Diseases of the Kidneys and Ureters*, vol. ii. p. 159) found that only 20·8 per cent. cures occurred in 48 cases treated without operation, whereas 51 per cent. out of 49 cases recovered after operation. Out of 56 cases collected by Leguen, 28·5 per cent. recovered without operation; it is probable that the obstruction was never complete in some of these cases.

Before operating, the surgeon should remember, that the stone is nearly always in the ureter of the only functional kidney, but that both ureters may become simultaneously obstructed in some cases, and also that two exceptional cases have been recorded in which a vesical stone closed the orifices of both ureters (Morris, *loc. cit.*). Morris draws attention to the three important factors in the production of calculous anuria.

1. "A long-standing change in one of the kidneys causing a diminution if not suppression of its function; or else a congenital anomaly (absence or atrophy).

2. "A recent or recently aggravated lesion of the principal kidney. This lesion is mechanical, and caused by a calculus.

3. "A reflex inhibitory effect upon the disorganised kidney, leading to complete suppression of its imperfect functional power."

The surgeon may restore the function of the principal kidney by a prompt removal of the obstructing stone, or failing this he may simply form a temporary fistula in the loin; the other kidney may then regain its use.

Diagnosis.—Calculous anuria can be readily distinguished from the temporary reflex suppression that may follow operations on the lower urinary organs, by the history, and from the uræmia of Bright's disease, also by the history and by the absence of the early and characteristic symptoms of non-obstructive uræmia, such as headache, nervous disturbances coma, and convulsions. The subject of calculous anuria may remain so well for many days, that it may be difficult to make him realise the gravity of his condition.

It is not always easy to tell the side of the principal kidney and the exact position of the calculus which has recently obstructed its ureter, but every effort must be made to determine these points, for the operation must be performed on the side of the healthiest kidney, which is nearly always the last affected.

A history of previous attacks of renal colic on one side and of a sudden recent onset of colic on the same side associated or rapidly followed by anuria, may indicate the affected side with more or less certainty, but if the last attack of colic, which has been followed by anuria, be on the other side the obstruction is practically certain to be on that side. Rigidity, tenderness and, more rarely, swelling on one side may confirm the diagnosis.

When no history of value is available, palpation may discover tenderness or rigidity over one kidney or ureter, although the subjects of anuria are usually too stout to allow palpation of the ureter. Rectal

and vaginal examination may enable the surgeon to feel a calculus low down, and Morris has detected a stone in the ureteral orifice after dilating the female urethra, and such a calculus has also been seen through the cystoscope. Examination of the ureteral orifices by means of this instrument may add a link to the chain of facts required for accurate diagnosis. Mr. Clayton Greene (*Lancet*, vol. i. p. 91, 1906) records a case in which it was fairly clear from other evidence that the obstruction was on the right side. The cystoscope showed a healthy right ureter, but the left orifice was distended with some whitish material which was thought to be a phosphatic stone. In this case the cystoscope proved that the calculus was not in the vesical part of the ureter, but it is clear, that, taken by itself, the appearance of the left ureter might have led to a wrong conclusion and an exploration on the wrong side. In cases of partial anuria, the segregator may serve to show which kidney is the principal one, as is demonstrated by the following interesting case recorded by Mr. Bruce Clarke (*Lancet*, vol. i. p. 5, 1905).

"The first instance in which I made use of it the segregator was one, as you will see, of obstructive suppression—that is to say, a case in which one kidney had been practically destroyed by a calculus and in which complete obstruction was being threatened owing to the impending blockage of the opposite ureter. Such cases when they are typical are not very difficult to detect, but in this instance no history could be obtained of a previous attack of renal colic or any evidence of even the probability of such an attack. The illness from which the patient was suffering had come on suddenly in a man, aged 46 years. He had been seized without warning with violent pain in the region of the left kidney and ureter which had temporarily yielded to fomentations, hot baths, sedatives, and rest in bed. Each time one of these attacks supervened there was an arrest in the secretion of urine, though it could hardly be said to amount to complete suppression. There had been some six or seven attacks in the past three weeks. The longest one had lasted three days and the shortest only a few hours, but latterly the pain had invaded both loins. The urine was highly coloured, tinged with blood sometimes, and there was a little pus in the specimen which I examined; it had a specific gravity 1014, gave an acid reaction, and contained a trace of albumin. The day before I saw the patient he had had a severe attack over the region of the right kidney and both loins were tender to touch. His temperature was a little raised and he was evidently ill. Though on the whole it seemed most probable that a stone in the pelvis of the left kidney afforded the clue to his symptoms, and recent pain over the right kidney region made the condition of that kidney a matter of considerable doubt. In these circumstances I introduced the separator, and within a few seconds urine began to issue from the left catheter. It was not until nearly half an ounce had come from this side that urine began to issue from the right catheter. In a quarter of an hour quite enough had been collected for purposes of examination and the instrument was withdrawn.

"The appearance of the urine from the two sides was absolutely different. That from the right side was small in amount (scarcely more than a teaspoonful) whilst three-quarters of an ounce had come from the left kidney. The examination of the two specimens yielding the following result. The urine from the right kidney was slightly alkaline and contained a little pus and some albumin; that from the left kidney was acid, clear, with not a trace of pus or albumin. It was now established beyond all possibility of doubt that the kidney on the left side was the working kidney and was presumably healthy, though it probably contained a calculus. The right kidney had probably been so damaged by some previous attack as practically to be useless.

"An operation was performed a few days later on the left kidney. The stone which I hold in my hand was extracted from its pelvis."

If one kidney is known to have been diseased for some time, and especially if it has been explored by an operation, the recent obstruction

is almost certain to be on the opposite side. When one kidney has been removed and anuria suddenly supervenes some time afterwards, it is imperative to explore the remaining kidney, but this has not always been done; thus a young woman had her left kidney removed for tuberculous disease. Some months later she was taken to another hospital suffering from anuria, which was considered to be due to tuberculous disease of the remaining kidney, but the autopsy disclosed a small calculus impacted in the right ureter and a hypertrophied healthy kidney.

With certain precautions, radiography may give information which may serve to complete the diagnosis by localising the stone, but a negative result must not be relied upon, because a stone which is large enough to obstruct the ureter may yet be too small or too transparent (uratic) to give a shadow in a fat subject. A positive result may also mislead, for a large calculus may be present in the pelvis of the other kidney, and only a small one in the ureter last obstructed. To arrive at a diagnosis, all the facts available must be reviewed and too much reliance must not be placed upon any one sign.

It must not be forgotten that cancer of the uterus and of the bladder may rarely cause sudden anuria, and lead to a hasty diagnosis of calculous anuria, but a thorough examination ought to prevent this mistake.

Morris relates a case of polycystic disease of both kidneys, which led to error. A history of passing gravel and a stone was very misleading in this case (Morris, Vol. I. p. 168).

The nature of the operation.—In most cases it is best to explore the kidney which is considered to be the principal one through the usual incision in the loin, and to remove any stone that may be discovered in the pelvis or the upper part of the ureter. Morris states that in twenty out of thirty cases, this incision would have served to remove the calculus at the primary operation. If a calculus cannot be found in this way, a ureteral catheter should be passed downwards to locate it. Sometimes it may be removed by prolonging the incision, or through a separate extra-peritoneal incision in the groin, if the calculus is lower down. In grave and late cases, however, it will be wise not to endanger the life of the patient by prolonging the operation unnecessarily, and to defer what may prove to be a difficult and long operation until the patient has recovered from his immediate danger; by forming a fistula the surgeon will have done all that is urgently required to save life, and to re-establish the secretion of urine.

If it be known beforehand that the stone is too low to be reached from the loin, extra-peritoneal ureterotomy should be performed at once, the stone removed through a longitudinal incision, and a catheter passed down into the bladder to make certain that the passage is clear. The incision into the ureter may be partly closed by catgut sutures, but it is not safe to invert the edges and thus to narrow the lumen of the only ureter, unless the latter be dilated at the site of the incision.

Blood clot in the lower part of the ureter may be sufficient to prevent or delay the return of urinary secretion as pointed out by Mr. Clayton Greene (*loc. cit.*). In any case a drain must be placed near the ureter to prevent possible urinary extravasation.

If the stone be known to be impacted at or near the lower end of the ureter, primary nephrotomy may be done in grave cases, and the calculus may be removed later, if not naturally passed. In one case a stone has been removed through the rectum.

Garceau (*Boston Med. and Surg. Journ.*, April 21, 1904) removed a stone which was impacted near the lower end of the ureter through an incision in the anterior vaginal wall. The operation only took ten minutes, and it was completely successful.

Sometimes, although very rarely, it may happen that all the efforts of the surgeon may not suffice to enable him to decide upon which kidney to operate. He must then explore one kidney through the loin, and if this be found to be atrophied or greatly diseased he must perform a nephrotomy on the other side. This is better than doing an exploratory laparotomy, for it may be very difficult to find and examine the ureters, especially in fat subjects (*vide* p. 186); and even if a calculus be found it is not wise to try to remove it through the peritonæum for several reasons. The contents of the ureter above the stone are very likely to be septic, and it may be necessary to drain the ureter, which is more safely done extra-peritonæally; if the incised ureter be sewn up, it may leak into the peritonæum later. Moreover, palpation of the kidneys may mislead the surgeon, the largest kidney being the most diseased one in some cases. Even if a correct diagnosis be arrived at by a laparotomy another operation is necessary to drain the kidney and remove the calculus, as in Mr. Duke's case (*Lancet*, 1904, vol. ii. p. 174). In this case all that the surgeon could discover with his hand in the abdomen was that the right kidney "was apparently a little larger than the left." On this slight evidence the right kidney was opened through the loin, and two calculi discovered in the pelvis; one of these, weighing 3·2 grains, was removed later, and the patient recovered, although she had suffered from complete anuria for ten days.

Cabot advocates exploratory laparotomy (*Ann. of Surg.*, October, 1904), if other methods fail to indicate the site of the recent obstruction. He relates two very interesting cases, in each of which the operation failed to discover the calculus, but probably served to dislodge it. In one case bimanual examination through a median laparotomy and an incision in the loin failed to discover the calcareous obstruction. In the other patient only a lumbar nephrotomy was performed. Both patients recovered.

One of the most brilliant examples of what nephro-lithotomy can do in some cases of suppression of urine is shown by a case brought by Mr. R. C. Lucas before the Medico-Chirurgical Society (*Trans.*, vol. lxxiv. p. 129) :

The patient, aged 37, had had her right kidney, a "mere shell, containing masses of stone weighing twenty-one ounces," successfully removed. Three months later she was seized with agonising pain in the back and left loin. Suppression of urine quickly set in, and on the fifth day a calculus was removed which was exactly of the shape to act as a ball-valve to the top of the left ureter. The patient made an excellent recovery, and has survived for many years now.

But in many cases of suppression the indications are less clear, and there is often much difficulty in deciding which ureter is blocked, owing to the deficient history. An excellent instance of such cases, in which

the surrounding difficulties were most successfully met, is recorded by Dr. Fraser and Mr. Parkin, of Hull (*Lancet*, vol. ii. 1893, p. 688) :

The patient here suffering from suppression of urine was 74 years of age. Beyond the evidence pointing to obstructive anuria, there was very little to throw light on the condition of the kidneys, or which organ should be explored. As the patient had been observed by her friends to support the left side in walking, and as there was deep-seated tenderness in this loin, Mr. Parkin explored the left kidney from the loin. The organ was enlarged, distended, and hypertrophied. About six ounces of urine escaped when the kidney was incised along its convex border, the last portion to come away being mixed with some pus. No stone was found, and the cause of the suppression must remain obscure, as the patient, though 74, made a good recovery, with a sinus from which most of the urine passed.

The above cases show the importance of knowing the history of the case, and, where this is deficient, making a most minute examination, no point being considered too trivial to be pieced in with others, before it is decided which kidney is the working one and now obstructed, and which is obsolete.

The Time for Operation.—Any operative interference should be undertaken, if possible, long before the final stage of constant hiccough and vomiting, subnormal temperature, irregular pulse, tremor, and drowsiness. As soon as the diagnosis becomes certain an operation should be resorted to, for it must be remembered that if the obstruction be too long continued, its removal may not relieve the suppression. A few patients have recovered after suffering from complete anuria for ten or more days, but others have died after three or four days. Cases of incomplete obstruction last much longer, of course.

Anuria following injuries is much less hopeful, owing to concomitant injuries. The following are examples :—

Mr. Cock recorded (*Path. Soc. Trans.*, vol. i. p. 293) the case of a young man who died comatose on the eleventh day after an accident. All the symptoms of the original injury and the subsequent peritonitis subsided in a few days, save that the catheter withdrew nothing but blood. The autopsy showed a ruptured single kidney. In Mr. Poland's case (*Guy's Hosp. Rep.*, vol. xiv.) the complete suppression of urine which followed an injury was due to thrombosis of the renal vessels of one kidney, and rupture of the pelvis on the other side.

Mr. Butler, of Guildford, records (*Lancet*, vol. i. 1890, p. 79) a case of suppression of urine lasting thirteen days. The necropsy showed that the ureter of the only working kidney (the left one) was greatly distended with urine and plugged by a solid hard body in about its centre. This proved to be a venous thrombus, which, formed in one of the veins in the kidney, had passed through a rent in the kidney tissue into the pelvis and ureter. Here the suppression came on four days after a blow on the abdomen. No symptoms had pointed to renal disease, and, save that the blow was on the left side, there was nothing to tell on which side the obstruction was.

NEPHRECTOMY.

Indications.

i. Cases of renal tuberculosis, preferably as the primary operation, and also cases of tuberculous pyo-nephrosis explored previously and drained by nephrotomy, but in which a discharging sinus persists. Here the kidney should be removed when the following conditions are favourable, viz., the age and strength of the patient, the absence of

visceral infection, tubercular or lardaceous, and, if possible, a date not too long deferred, for the additional reason that the kidney will be increasingly matted down and difficult of removal, while its fellow may have become involved in the disease.

On this point I may quote again from my paper on the conditions which simulate renal calculus (*Brit. Med. Journ.*, 1890, vol. i. p. 117):

"I would most strongly urge this course (early exploration of the kidney) with a twofold object: (1) to clear up the case and (2) to perform nephrectomy if the kidney is found to be the site of so fatal a disease. If I am told of the un wisdom of this step, owing to the probability of both kidneys being affected, I would reply that, as a rule, both kidneys are not affected at an early stage. Thus Dr. Fagge (*Medicine*, vol. ii. p. 488) gives a list of thirteen cases which show 'the characters of tuberculous disease of the kidney at its commencement.' In only three of these were both kidneys affected, and in all these tubercular mischief was present in the bladder also. If during this early exploration one or two pyelitic dilatations are found, extirpation of the kidney should be performed while the organ is still small and movable, and before the rest of the genito-urinary tract becomes involved.

"I need not remind my hearers of the miseries which lie before a patient with established tubercular kidney, the results of ulceration of his bladder, with, perhaps, vomicæ in his prostate, and the inevitable course downhill, arrested, it may be, for a little while by nephrotomy and drainage."

My own experience of drainage alone in established tubercular kidney is most unfavourable, the relief being slight and short-lived, and not arresting long the hectic and increasing debility. On the other hand, in four cases in which I have been able to perform nephrectomy early (cases Nos. 8, 12, 13, 16, p. 217) the result has been most satisfactory. In four others (3, 4, 11, 17, *ibid.*), the recovery, though less complete, was very satisfactory. Finally, in two (cases 15 and 22, *ibid.*), the eleventh and twelfth cases in which I have removed a tubercular kidney, the disease was too advanced in both for the result to be satisfactory.

Pousson (*Lancet*, Aug. 11, 1900) found that out of 63 cases of nephrotomy 39 died in the first year from the spread of their tuberculosis or complications arising from incomplete operation. Twenty-four were alive, some of these were known to have survived for two, five, and ten years, but all of them had fistulæ.

Ramsay (*loc. cit.*, p. 161) gives the results of 191 cases of primary nephrectomy for renal tuberculosis. Of these 106 were noted as cured, 31 were improved, 37 died within one month of the operation, and 17 died at a later period.

Forty-nine cases of secondary nephrectomy after a previous nephrotomy are also given. Of these 18 died shortly after the operation, and 23, or 46 per cent., were cured. Of the 37 deaths resulting from primary nephrectomy, 9 were due to uræmia, 3 to tuberculosis of the other kidney, and 2 to amyloid degeneration of the other kidney. These 14 deaths serve to emphasise the importance of thorough investigation of the capacity of the other kidney before nephrectomy is decided upon. For although the second kidney, as mentioned above,

is not often affected in early cases, yet when the case only comes under observation in the more advanced stages, it will very possibly be diseased (*vide* pp. 150 to 160).

Pousson (*Lancet*, Aug. 11, 1900) strongly advocates primary nephrectomy at an early date, giving its mortality as 21·79 per cent., whereas that of secondary nephrectomy is 30·76 per cent.

The cystoscope and the segregator, used with caution and full knowledge of possible fallacies, are very valuable in determining the state of the other kidney. Ureteral catheterisation is to be condemned as difficult, dangerous, fallacious and unnecessary in these cases. The importance of estimating the total amount of urea and of the share taken by each kidney in its excretion has been already alluded to (p. 159). Undoubted tuberculous ulceration of the bladder, unless limited to one ureteral orifice, is a strong contra-indication to nephrectomy, but care must be taken not to mistake simple or septic cystitis, which is often associated with tuberculosis of the kidney, for tuberculous disease.

Should the condition of the other kidney still remain doubtful after the available methods of investigation have been exhausted, then it becomes necessary to examine it by means of an exploratory incision. If the segregator can be used the need for this operation can scarcely arise. Edebohls (*Ann. of Surg.*, April, 1898) advises a lumbar exploration, and this is doubtless the safer and more certain method. The disturbance caused will be comparatively slight, and is more than balanced by the additional security that the surgeon will feel when proceeding to perform nephrectomy a week later. The doubtful utility of examination of the other kidney through an abdominal incision has been referred to above (p. 186). Mr. Barling (*Ann. of Surg.*, March, 1906, p. 418), however, recommends palpation of the opposite kidney through an incision into the peritoneum at the anterior part of the usual lumbar incision. This plan is certainly simpler than making a separate abdominal or lumbar incision, although it cannot be said to be as reliable as the latter, the eye being more trustworthy than the hand. These remarks apply equally to the two following conditions, calculous disease and hydro-nephrosis.

ii. Calculous pyelitis or pyo-nephrosis where the kidney is destroyed by long formation of calculi and consequent suppuration, where numerous calculi exist with sacculation of the kidney, or where a large and branching calculus is so embedded as to resist removal. These indications for nephrectomy have been already considered under the heading "Nephro-lithotomy" (p. 180), as it is during the performance of this operation that the question of removing the kidney for the above conditions will arise.

iii. A kidney the site of hydro-nephrosis or pyo-nephrosis in which the cause is irremovable, or the kidney beyond hope of recovery (Barling, *loc. cit.*). The treatment here will vary according to the degree to which the disease has advanced. Aspiration, lumbar nephrotomy, and drainage, the edges of the cyst being stitched in the wound, and nephrectomy have each been advocated here. Occasionally repeated aspirations are sufficient, as in Mr. Croft's case (*Clin. Soc. Trans.*, vol. xiv. p. 107), in which eight aspirations (through the lumbar region) within four months, between three and

four pints being withdrawn each time, sufficed to cure a hydro-nephrosis in a boy aged 12. It is noteworthy that the case was distinctly traumatic in origin, and that the last fluid withdrawn contained a very large amount of albumen. It is for such cases, especially if the interval between the aspirations lengthens each time, that aspiration should be reserved. This method is, however, so rarely successful that the surgeon will, in advanced cases, have to decide between nephrotomy and drainage, and nephrectomy. It is now acknowledged by the advocates of the former step that it has given less favourable results than were expected. The time taken is usually very great, the frequent change of dressing necessitated by the constant soakage is most irksome, and, later, the wearing of a lumbar urinal is most inconvenient, leading as it often does to an eczematous, raw area around the sinus. The sinus, moreover, is liable to become foul and to contain phosphatic material. The tube also, which leads into the urinal from the sinus, easily becomes blocked, and causes much discomfort from redistension of the cyst.

During the operation of nephrotomy the ureter must be carefully examined with the view of discovering any removable obstruction in the form of a kink, valve, stricture, or a calculus placed low down. A ureteral catheter should be passed as far as the bladder to make certain that the tube is patent.

In future, nephrectomy will be oftener performed for hydro-nephrosis where the kidney is much altered, either as a primary operation or after allowing a sufficient interval to elapse for shrinking of a large cyst, but no prolonged delay. Where, therefore, the patients are young, with every prospect of a long and active life before them, where a month's drainage has failed to bring about any considerable diminution in the amount escaping, and where the fluid thus coming away contains but a small amount of urine, and where there is evidence that the other kidney is competent, the cyst and remaining kidney tissue should be extirpated from the loin before it has become more firmly matted to the surrounding parts.*

A papilloma of the renal pelvis may cause a large hydro-nephrosis with destruction of the renal tissue. Dr. Reynolds (*Ann. of Surg.*, 1904, vol. xxxix. p. 743) describes such a case requiring nephrectomy. Albarran and Imbert were only able to collect accounts of 22 cases. It is possible that early diagnosis may enable the surgeon to save the kidney by removing the growth only, but it should not be forgotten that these growths are very liable to become malignant.

In cases where the hydro-nephrosis is early and due to movable kidney nephrorraphy will often suffice (p. 220). In a few other cases the hydro-nephrosis may be due to valve or stricture of the ureter. For an account of the different operations performed for the relief of these conditions, I may refer my reader to the surgery of the ureter (p. 241).

iv. Certain cases of malignant disease. These fall into two groups, which must be looked at separately from an operative point of view.

* If in hydro-nephrosis, after an exploratory nephrotomy, bloody urine descends into the bladder, the indication for leaving the kidney will be greater, especially if the viscus show a cortex of fair thickness, and is not a mere sac with little, if any, secreting tissue.

One group, the *sarcomata*, occurs in children before 10, usually much earlier, before 5. In such cases the risks of immediate death from shock, aided often by peritonitis, of early recurrence, or of death from secondary deposits elsewhere, should be put clearly before the parents, together with the certainty of an early death if the growth is left.

The other group, the *carcinomata*, occurs usually in patients past middle age.

In either case an operation should only be performed in an early stage, while the growth is still internal to the capsule, and while the strength, health, and condition of the viscera are satisfactory. On the other hand, where the history makes it probable that the growth has got beyond the earlier stage, when there is any extension to the lumbar glands or other viscera, when there is nausea, emaciation, hæmoptysis or a temperature inclined to fall, the time for operation has gone by. So, too, any ascites or œdema of the lower limb are absolute contra-indications. Varicocle is so uncertain a symptom, that it cannot be held to contra-indicate operation (Richards, *Guy's Hosp. Rep.*, vol. lix.).

With regard to the frequency of secondary deposits, the fact that Dr. Dickinson* found these to be present in no fewer than 15 out of 19 cases strengthens, very decisively, the argument in favour of early operations while these growths are small, at which time, moreover, they can be successfully attacked through a lumbar incision sufficiently enlarged by the steps given at p. 205, or by one made anteriorly.

Much information may be gained from a very complete study of sarcoma of the kidney in children by Mr. George Walker, of Baltimore (*Ann. of Surg.*, vol. ii. 1897, p. 529 *et seq.*). In all, 74 cases in children in which nephrectomy was performed are here collected. Of these 27 died from the effects of the operation, 28 died from recurrence, 14 passed out of sight, and 4 remained well from three to five years after the operation. The immediate mortality is therefore 36·4 per cent. Though still very high, this is a vast improvement on the earlier published figures; for instance, Butlin (*Oper. Surg. of Malig. Disease*, p. 254) gives 60 per cent. As regards cures, 4 cases, or 5·4 per cent., may be considered as probable cures, but it is quite possible that some of the 14 cases that passed out of sight were cured, since they were all of them well when last heard of; in this case, 5·4 per cent. is too low. Since the publication of this paper one of the supposed "cures" died of recurrence or of independent and similar disease in the other kidney, and 2 incomplete cases have been reported to be well after six and ten years respectively. So that the proportion of cures may now be said to be at least 6·7 per cent. Briefly, the most important points in connection with four of these successful cases are as follows:—

1. *Israel's case*. Boy aged 14 years. The tumour, about double the size of a man's fist, was removed through a T-shaped lumbar incision. The peri-renal fatty tissue was freely excised after removal of the growth. Well five years later.

2. *Schmidt's case*. Girl aged 6 months. The tumour was the size of a child's head, and was removed through an incision two fingers' breadth to the left of the middle line of the abdomen. The peritonæum was not sutured. The child was well four years later.

3. *Abbé's case*. Girl aged 2 years. The tumour, which weighed 2½ lbs., was removed

* *Dis. of the Kidney and Urinary Derangements.*

through a transverse incision extending from the lumbar region to near the middle line of the abdomen. The child was well four years after, but she died of sarcoma of the other kidney nine months later.

4. *Abbé's case.* Girl 14 months old. A transverse incision was again used, extending from the middle line of the abdomen to within 6 cm. of the spine. The child weighed 15 lbs., the tumour $7\frac{1}{2}$ lbs. The child was well three and a half years later.

Another successful case is described by Malcolm (*Clin. Soc. Trans.*, vols. xxvii. and xxviii.), the child being in good health two years and four months after the operation.

Morris (vol. i. p. 603) concludes that the mortality from the operation has been reduced to between 20 and 25 per cent., and thinks that it is not likely to fall much lower than this.

Heresco (*Thesis*, Paris, 1899, and quoted by Owen Richards in an excellent paper in the *Guy's Hosp. Rep.*, vol. lix.), in his 53 cases in infants operated upon since 1890, found a mortality of only 17 per cent.

Ultimate Results.—Over 10 per cent. of the adult cases “were ‘cured’ in the sense that they were known to be well at the end of three years, and are not known to have had recurrence since,” although the results are less favourable in children, about 7 per cent. of “cures” occurring (Owen Richards).

Mr. Walker also compares the length of life, from the time of the discovery of the tumour, in cases not operated on with those that were operated on. In 68 cases not operated on the average length of life was 8·08 months; in the operation cases the average was 16·77 months, an average gain, that is, of 8·69 months by operation.

Since this disease, when left to itself, is necessarily always fatal, a rate of cure after operation of nearly 10 per cent. constitutes very strong evidence in favour of operation wherever there is a reasonable hope that the whole of the disease can be removed.

With earlier diagnosis and improved technique, it is to be hoped that a still greater measure of success will obtain.

To secure this improvement the following points deserve attention. An exploratory incision should be made as soon as obstinate pain and swelling (perhaps revealed by an anæsthetic), or free and recurrent bleeding shown to come from one kidney by means of the separator or the cystoscope or both, call attention to the possibility of a growth, and before time has elapsed for lymphatic infection. Where the case comes before the surgeon in a more advanced stage, he should bear Mr. Malcolm's advice in mind. As in the “treatment of new growths elsewhere, the more definite the outline of the tumour, the more mobile it is, the slower its growth, the better the state of the patient's health—in fact, the stronger the evidence that the patient is only locally affected—the more likely is operative treatment to be followed by prolonged immunity from disease.” Cases may be observed, on the other hand, in which the tumour has no definite outline, being fixed to and incorporated with the neighbouring structures, so as to be absolutely immobile, being also of very rapid growth and accompanied by extreme emaciation. Such cases are obviously unsuitable for surgical interference. “Before the operation every precaution should be taken against shock. Thus the limbs should previously be bandaged in cotton wool, the site of the wound only exposed, the head kept low, injections

of brandy and strychnine should be ready, ether administered, warmth maintained by operating on a hot-water table when possible, and warm irrigating fluid used. Finally, an assistant should always be at hand to perform saline infusion, and this, if used, should be resorted to before the close of the operation, when the condition of shock may be irremediable.”*

During the operation itself the incision must be sufficiently free. The lumbar one, carried very freely forward† (p. 205), will give sufficient room for all except large tumours. The peritonæum will only be opened when the growth is very large or adherent. Where grave shock is imminent, hæmorrhage may be controlled by forceps left *in situ* for thirty-six or forty-eight hours. It is easy to prevent a child from rolling on to these by packing the patient firmly on either side with pillows in a cot. Finally, as Mr. Malcolm has shown, every vestige of the capsule, and all fat adjacent to it, together with any fat or glands about the renal vessels, should be removed.

The removal of renal growths through an anterior trans-peritonæal route used to be attended by about twice the mortality of the lumbar operation. This was chiefly due to greater risk of sepsis, but also to the fact that this method was used particularly for very large growths, considered to be too big to be removed through the loin.

In later cases, as shown by Heresco (*loc. cit.*), there has been very little difference in the mortalities of the two methods.

Morris strongly advocates a combination of the lumbar and lateral trans-peritonæal methods for malignant tumours of the kidney. He first explores through the linea semilunaris and examines the connections of the tumour; then, after temporarily closing this incision, he enucleates the kidney through the usual incision in the loin. The original wound is then reopened and the peritonæum raised from the tumour, the pedicle secured, and the growth pushed and delivered through the anterior incision.

It is claimed that this method enables the surgeon to thoroughly explore the tumour and to determine the presence or absence of early secondary growths in the peritonæum and abdominal viscera before beginning the enucleation; also that the risk of injury of the great vessels is less than if either an anterior or posterior incision is used alone; that the delivery of the tumour forwards is facilitated by a hand in the posterior wound. Moreover, the lumbar wound is the best for drainage.

v. Certain cases of injury. These are very rare, and fall into the following groups: (a) Where an injured kidney protrudes from a wound of the abdomen, usually the loin. (b) In some cases of non-penetrating wound of the kidney, as when it is ruptured from a fall or blow. (1) Where hæmaturia does not yield to treatment,‡ the bleeding

* Dr. Abbe strongly advises the use of the Trendelenberg's position as emptying the blood from the growth into more important parts, and the injection of strong coffee and brandy into the rectum after the operation.

† Dr. Abbe used a similar one in his two successful cases mentioned above.

‡ In Mr. Rawdon's case (*loc. infra cit.*) nephrectomy was performed for hæmorrhage after an injury, but at rather a later date—*e.g.*, on the seventeenth day after the fall—to prevent blood from entering the bladder and increasing the acute cystitis present. Here the hæmaturia had diminished at first, and subsequently increased.

being well marked, or latent and insidious, giving evidence indirectly of its existence by the increasing pallor, the failing pulse, impending syncope, and perhaps a swelling in the loin, as in case No. 20, Table, p. 219. (2) Later on, when the injured kidney is setting up serious suppuration, which does not yield to drainage. (3) For ruptured ureter and traumatic hydro-nephrosis. Mr. Barker has recorded (*Lancet*, Jan. 17, 1885) a most successful case, in which, after other treatment had failed, he removed a kidney three months after the rupture.

The child, aged $3\frac{1}{2}$, had been run over, but beyond some bruising and one small clot passed there was nothing to point to injury of the urinary tract. Having left the hospital in a fortnight, apparently convalescent, he was, a few days later, admitted with a fluctuating swelling in the right loin. This increasing, was aspirated, the fluid yielding $\frac{1}{2}$ per cent. of urea. The swelling was subsequently drained, and the drainage-tube becoming blocked with phosphatic deposits, and thus causing a good deal of constitutional disturbance, the kidney was removed. It proved to be healthy, the ureter being torn across just below it.

At the present time, if this condition be discovered at an exploration for traumatic hydro-nephrosis, it may be found possible to save the kidney by performing a plastic operation on the ureter. Tilden Brown, however, failed to discover a rent in the ureter until suppurative nephritis had developed, and he was forced to remove the kidney about seven weeks after the injury (*Ann. of Surg.*, 1905, vol. xli.). When the ureter is accidentally divided during a pelvic operation, if the calamity is discovered at once immediate anastomosis should be performed. If this fails, and suppurative nephritis and a fistula follow, then nephrectomy may become necessary.

(c) Penetrating wounds. Very rarely indeed nephrectomy may be called for here (1) when hæmorrhage does not yield to treatment aided by exploration and plugging; (2) when a urinary fistula persists after such a wound in certain cases—*e.g.*, when the other kidney is healthy.

(d) Gunshot wounds. Owing to the increase of revolver-injuries and recent advances in abdominal surgery, this matter has lately received much attention.* Whether in civil or military practice, gunshot wounds of the kidney are only too likely to be complicated with injuries of the intestines, liver, and spine. When, in the course of an exploratory operation in the case of a gunshot wound of the abdomen, the kidney is found to be the seat of hæmorrhage, if uncontrollable by other means, nephrectomy should be performed.

vi. In a very few cases of movable kidney. Where nephrorraphy has been properly performed, as, *e.g.*, by the method given at p. 224,

* As might be expected, American surgeons have not been slow to avail themselves of their opportunities. Prof. Nancrede (*Ann. of Surg.*, June, 1887, p. 480) suggests that where the renal or splenic artery is cut by a bullet the viscus should be removed, as gangrene is inevitable. Dr. Parkes (*loc. supra cit.*, November, 1887, p. 379), in a case of bullet-wound of the abdomen, having sewn up five perforations of the intestine, found that the left kidney was perforated. The hæmorrhage was very slight at this time. After doing well for twenty-four hours, the patient began suddenly to fail, and died, collapsed, from hæmorrhage from the kidney. Dr. Parkes regretted that he had not performed nephrectomy. Dr. C. Briddon, of New York (*Ann. of Surg.*, 1894, vol. i. p. 641), in three cases explored an injury to the kidney by a lumbar incision at a date varying from one to four weeks after the accident, and by evacuating bloody urine, foetid clots, irrigating, and tamponnading with iodoform gauze, saved his patients from a state of grave peril.

nephrectomy will never be required. In a few cases nephrorraphy will fail, owing to the complication of organic disease, as in the instances given at p. 221.

vii. For a few rare diseases of the ureter. Israel's case (quoted at p. 168) of chronic ureteritis, for which nephrectomy was performed, may be again referred to here. Another very instructive case, one of ureteral papillomata, is described by Le Dentu and Albarran (*Bull. de l'Acad. de Méd.*, No. 9, 1899) :

Male, 33, had had frequent attacks of renal colic for which nephrotomy had been performed without benefit. A diagnosis of ureteral papilloma was arrived at by means of the cystoscope. The kidney and ureter were therefore removed. The kidney was hydro-nephrotic, and the ureter contained two papillomata, one three-quarters of an inch below the renal pelvis, the other at the vesical orifice.

viii. Hydatid disease of the kidney. Jerosch (*Centralbl. f. Chir.*, No. 38, 1899) has recently recorded two cases of nephrectomy for this rare condition. In the first case, death took place on the third day from exhaustion; the second case recovered.

The results of nephrectomy for hydatid disease have been poor, but in several instances this was due to excision of the only kidney,* a mistake which should be avoidable at the present day by adopting the methods of thorough examination advocated at p. 149.

Morris points out that the structure of the kidney may not be seriously affected by hydatid disease, and that nephrotomy is therefore more suitable than nephrectomy, which should only be adopted when there is "suppuration of the kidney, or rupture of the hydatid cyst into the lung or peritonæum." Secondary nephrectomy may be found to be required if nephrotomy and drainage, or excision of the cyst, fail to cure the disease.

ix. Cystic disease. Surgical interference for polycystic disease of the kidney has been generally considered to be unwise, because of the frequency of bilateral disease, and the belief that the second kidney may rapidly develop the same disease after the removal of the first. There are *exceptional cases*, however, in which nephrectomy is called for. These are cases in which the disease has been proved to be unilateral, and the symptoms are grave from rapid growth and increasing distension, and especially when repeated and profuse hæmaturia occurs.

Morris performed nephrectomy in four cases. Two of the patients were well three and seven years later, one died of similar disease in the other kidney four months later, and the other died on the second day from suffocation due to vomiting.

Morris (vol. i. p. 66) advocates his combined operation, with examination of the other kidney, by palpation, which he considers satisfactory in these cases, any enlargement being easily detected. When the condition is discovered for the first time during a lumbar exploration, the other kidney should be explored through the loin, or through the anterior end of the wound already made (Barling, *loc. cit.*), before proceeding to excise the diseased kidney. This course may not be always necessary, for the cystoscope, the segregator, and estimation

* Houzel, quoted by Morris, vol. i. p. 681.

of the urea, may have afforded ample evidence of the condition of the other kidney. It may be easy to tell that the kidney which is displayed in the wound is so diseased that it can take very little or no part in the excretion. In two cases known to me at Guy's Hospital, it was considered to be unnecessary to explore the opposite kidney for these reasons. Both of them did well. The first had repeated and severe attacks of unilateral hæmaturia, which was thought to be due to malignant growth; the other was diagnosed as a tuberculous pyo-nephrosis. It must not be forgotten that a large cystic kidney may not be palpable through the parietes. Dr. Bevan (*Ann. of Surg.*, 1906, vol. xxxix. p. 467) removed a large polycystic kidney which he discovered during an exploration for hæmaturia with severe pain on one side. The condition of the other kidney was not known, but the patient recovered and was well a year later. Dr. Parker Syme (*loc. cit.*, p. 598) was unable to discover any enlargement of one kidney in a very thin woman with flaccid abdomen, and he therefore judged that it was not enlarged; therefore when the other kidney, which was greatly enlarged, was proved to be cystic on exploration, it was removed. The patient was quite well a fortnight later. It is needless to say that the after-history is too short. Dr. Haynes (*loc. cit.*, p. 599) candidly reported the removal of one of two cystic kidneys, the patient dying uræmic a fortnight later.

x. Aneurysm of the renal artery. Prof. W. W. Keen (*Philad. Med. Journ.*, May 5, 1900) reports a successful case of nephrectomy for this rare form of aneurysm:

The patient was a lady, aged 45, who had suffered for about five years from severe attacks which began with chilly sensations, followed by nausea and considerable rises of temperature. These attacks lasted a variable time and were thought to be "bilious." Once only, during the last attack, there was a small amount of blood in the urine. A large tumour, thought to be probably a hydro-nephrosis, was found occupying the whole right ilio-costal space, and extending from the right flank to a point about 5 cm. beyond the middle line. The tumour, which was removed without great difficulty, was found to consist of the kidney flattened out on the surface of a large aneurysm of a branch of the right renal artery.

Prof. Keen gives abstracts of twelve similar cases, two of which were operated on. Recovery took place in both these. Prof. Keen remarks that "there is nothing peculiar about any of the three operations other than the danger of hæmorrhage, especially from the pedicle. In my own case the pedicle was broader than I have ever encountered in any prior case of nephrectomy, so that I had to tie it in seven different sections. All three of the operative cases have terminated in recovery, a most encouraging outlook for the future."

Operations.

These are: A. Through the Lumbar Region. B. Through the Abdominal Wall, and the Peritonæum as well—(a) by an incision at the outer edge of the rectus; (b) by one in the linea alba. C. Through the Abdominal Wall without opening the Peritonæum. These methods are compared at p. 212. D. A Combination of the Abdominal and Lumbar Incisions. E. Morris's Combined Method. F. Knowsley Thornton's Combined Method.

A. Lumbar Nephrectomy.

Operation.

The position* of the patient and the earlier steps are much as those already given in the account of nephro-lithotomy, p. 172.

When the lumbar fascia has been slit up and the fat around the kidney torn through, this organ should be well thrust up by an assistant making careful, steady pressure with his fist against the abdominal wall; the wound being now widely dilated with retractors, the surgeon examines the kidney, and has next to decide on three points: (1) Is removal required? † (2) Will more room be wanted? If so, the incision already made, slightly oblique and about half an inch below the twelfth rib, should either be converted into a T-shaped one by another made downwards from its centre, or at its posterior extremity, along the outer edge of the quadratus lumborum, or continued downwards and forwards, as described under "Nephro-lithotomy" (*vide* p. 173). Additional room may also be gained by an assistant slipping his fingers under the lower ribs and drawing them forcibly upwards. (3) Is the kidney firmly matted down or no? If there has been no surrounding inflammation, the extra-peritoneal fat, the peritonæum, and colon will be readily separated by the finger working close to the kidney until the pelvis and vessels are reached. But if inflammation has caused firm adhesion and matting down of the kidney to adjacent parts, the altered fat and thickened and adherent capsule must be divided down to the kidney itself, and this gradually enucleated (partly with the finger, partly with a probe-pointed bistoury) from out of its capsule, which is left behind. This method is not to be recommended unless it is absolutely necessary, because disease may be left behind, troublesome fistula may persist, or a hæmatoma may form within the rigid walls of the cavity (Morris, *Lancet*, Jan. 1, 1898).

The only guide in such a case is the tissue of the kidney itself, close to which the finger and knife must be kept.

A case of Mr. H. Marsh's well shows this difficulty:

Removal of the kidney could not here be effected, owing to its size and the firmness with which it was embedded in the surrounding condensed areolar tissue. That part of the kidney which had been exposed was accordingly transfixed with a strong double ligature, and cut away. Complete suppression of urine followed the operation, and the patient died in about thirty hours. At the post-mortem examination the remaining part of the right kidney and its ureter were found to be so firmly embedded in dense cicatricial material that they were dissected out only with difficulty. The kidney itself was converted into numerous sacculi, in the walls of which, however, some remains of renal structure could still be traced. The opposite kidney weighed 6 oz. Its capsule was adherent, and there were two or three cysts on its surface. On section its structure looked somewhat confused and cloudy, but its condition was not such as to indicate advanced disease.

Mr. Greig Smith stated (*Abdom. Surg.*, p. 508) that, in cases of old-standing suppuration with great enlargement, the vena cava and the

* Additional care should be taken to open out the space between the last rib and the crest of the ilium by the arrangement of pillows underneath the loin; the precautions given to avoid shock (p. 199) must also be taken here.

† This question has already been alluded to in the case of a strumous kidney incised and drained (p. 194); in that of a kidney much damaged by one or more calculi, under the subject of nephro-lithotomy (p. 180); and in the case of hydro-nephrosis (p. 196).

aorta may be intimately adherent to the capsule. "One such case was met with in the post-mortem room of the Bristol Infirmary; here it was simply impossible, after death, to dissect apart the venous wall and the renal capsule. In another case, for similar reasons, the organ could not have been removed by any proceeding claiming to be recognised as surgical."*

If further room is still required, this may be easily and effectually gained by making use of additional incisions, as recommended under "Nephro-lithotomy," or by adopting the method advocated by Prof. König, of Göttingen (*Cent. f. Chir.*, 1886, Hft. 35; *Ann. of Surg.*, November, 1886, p. 445). This surgeon, having found great difficulty in getting free access to the kidney by the ordinary lumbar incision, cuts through the soft parts vertically downwards along the border of the erector spinæ to just above the iliac crest. He then curves the incision towards the navel, and ends at about the outer border of the rectus, if necessary going through this muscle to the umbilicus. It may be often advisable to make the perpendicular cut oblique, running in a flat curve into the umbilical part. All the muscles are incised quite down to the peritonæum. This method gives a surprisingly free entrance, but it can be much improved by introducing the hand through the perpendicular part of the cut, separating the peritonæum in front and pushing it forwards. Prof. König proposes to call this the retro-peritonæal lumbo-abdominal incision. If sufficient space is not thus afforded, or if, for diagnostic or operative purposes, it is desirable to approach the tumour from the abdominal cavity, the peritonæum can be divided in the transverse cut. If infective material is to be removed, this peritonæal opening must be carefully looked after. The need of free division of muscular fibres, involving undue liability of ventral hernia, is a serious objection to adopting König's incision.

Very large kidneys and renal tumours can be got out through very free lumbar incisions. I may state here that I twice, in 1890, removed kidneys eight inches long through the very limited ilio-costal space of little children aged respectively 3 and 3½. One was a case of sarcoma, the other of cystic kidney. Both made excellent recoveries; but as in the former the renal vein was thrombosed with growth, it was clear that a few months would see the end. In each case the lumbar incision was carried forward very freely, and the long axis of the tumour brought out in that of the wound.

In both Abbe's successful cases of sarcoma (*vide supra*, p. 198) long transverse lumbar incisions were found to give ample room, in the second case the tumour weighing 7½ lbs. in a child only 14 months old. Many other cases might be quoted.

The danger of ventral hernia is guarded against by using deep sutures, by allowing only gentle movements at first when the patient gets up, and by the use of a support. By these means the risk of hernia may be reduced to a minimum.

* As will be seen from case 22 in the table at p. 219, in which I injured the vena cava in the case of a large tubercular kidney, very adherent, the most difficult case I have met with. In a case of attempted nephrectomy (*Amer. Journ. Med. Sci.*, 1882, vol. ii. p. 116) the removal of the organ was rendered impossible, not only by its adhesions to the tissues around, but also, as was proved post mortem, to the colon and pancreas as well.

When the kidney has been sufficiently enucleated either out of its capsule, or, together with this, out of the peri-renal fat, the vessels and ureter must be dealt with. The latter should be taken first, as this step, especially if the ureter be enlarged, will facilitate dealing with the vessels.

If the ureter is dilated, and contains foul pus or tubercular matter, it should be tied with catgut and divided as low down as the pelvic brim or lower if necessary, and the stump carefully cleaned out with a sharp spoon and dusted with iodoform, or cauterised with strong carbolic acid. The diseased ureter should be removed with the kidney, its lower extremity having been clamped to prevent infection of the wound.

The vessels are then tied in at least two bundles with sufficiently stout carbolised silk, or chromic gut. This is passed, with an aneurysm-needle of sufficient length and suitable curve, through the centre of the bundle, each half of which is tied separately, and finally one of the ligatures is thrown round both halves together. In passing the ligatures, they should be pushed well in towards the spine, so as to leave ample room between them and the kidney to prevent all risk of their slipping. If the kidney can be raised out of the wound, passing the ligature is much simplified. If this is impossible, the surgeon may find help by having the lower ribs well pulled up by an assistant, while another keeps the kidney well up by pressure against the abdominal walls, light being also thrown in, in case of need, by a forehead mirror or electric lamp. While the ligatures are being tied and the pedicle divided, no tension should be put upon the vessels.

As soon as the ligatures are secured in position, the pedicle is snipped through at a safe distance from them with blunt-pointed scissors. If the pelvis of the kidney contains foul or tubercular pus, and if there is room, a large pair of Spencer Wells's forceps should be put on the ureter, and the pedicle cut through between this and the ligatures, so as to prevent the escape of septic material. If any hæmorrhage now takes place, it is probably due to some vessel* not being included, or to an artery having slipped through the knot owing to the parts being stretched at the moment of ligature. The bleeding point, to which the ligatures will act as guides, is now secured with forceps and ligatured. The ligatures are then cut short.

When a pedicle presents especial difficulties from its shortness, thickness, and the way in which it is overlapped by the kidney, a preliminary ligature should be applied and the kidney cut away well in front of

* The late Mr. Greig Smith (*loc. supra cit.*) gave the following practical hints as to the vessels:—The veins are a good deal larger than the arteries, and overlap them. At the hilum the veins branch quite as much as the arteries—i.e., four or five times—and the subdivision extends farther towards the middle line. It is very frequent for two or more trunks to represent the renal vein, and sometimes surround the artery. The want of uniformity in the renal vessels is against the possibility of ligaturing the artery and vein separately. In many cases this will be found impossible; in none is it necessary. Indeed, the walls of the veins, by acting as a sort of padding, may add to the safety of ligatures, preventing the thread from slipping. Mr. Greig Smith further states that the only deaths as yet recorded from secondary hæmorrhage were in two cases where the vessels were separately tied.

it,* a step which will give access to the vessels and ureter; a double ligature is then applied behind the temporary ligature, which is now removed. Again, where the pedicle is very short, a portion of kidney may be left to ensure the ligature retaining a safe hold. I was obliged to adopt this course in a case of nephrectomy for calculous pyelitis in which I had removed twelve stones a year before (case No. 7, Table, p. 217). A sinus persisted, which became abominably septic. As the stump of the kidney was foetid, I inserted no sutures, and packed the wound with strips of sal alembroth gauze wrung out of turpentine. The patient made a good recovery.

A modification of the method of leaving a portion of the kidney to form the pedicle may be made use of in cases of kidneys of large size which cannot be brought through the wound. In such cases, the vessels having been secured by a temporary ligature or by Spencer Wells's forceps, the kidney should be cut away in separate portions, thus doing away with the struggle required in bringing out a large kidney and the risks of producing serious shock by pulling on the vessels.†

Another means of treating the pedicle, where this is short and matted down, is to cut it through piece by piece, securing each bleeding point with compression forceps, and tying them off one by one. Or the vessels may be underrun, as in excision of the knee, but on a larger scale and more *en masse*.

By such methods as the above the risk of wounding the cava or aorta is avoided. If the amount of kidney left is small, it will no doubt atrophy and give no further trouble, but if large, some sloughing will probably take place; in such a case, iodoform or glutol should be dusted on to the stump and free drainage provided.

Another difficulty which may be present now is caused by the kidney having contracted adhesions to the peritonæum and some of its contents.

I have three times opened the peritonæum when using the lumbar incision. To one case, a nephro-lithotomy, I have alluded at p. 178; the other two were cases of growth and tubercular pyelitis, for which I was removing the kidney. All three cases recovered. The opening, in the two latter cases a small one, was at once covered by an aseptic sponge, and sutured with fine chromic gut.

* Dr. Lange (New York Surg. Soc., Nov. 22, 1886; *Ann. of Surg.*, April, 1887) has shown that in a case in which he adopted this course no sloughing took place, as the thick, fleshy part of the pedicle beyond the ligatures was gradually absorbed by the healthy granulations of the wound, which remained aseptic. Dr. Leopold (*Arch. für Gynäk.*, xix. 1), in a case of nephrectomy, tied the pedicle in three, and left a triangular portion of the kidney parenchyma, in order to prevent hæmorrhage. The patient made a good recovery.

† The question of how far serious shock may be induced by tightening ligatures on parts in such intimate relation with the abdominal sympathetic centres is one of great importance and needs further investigation. According to Mr. Barker (*Dict. of Surg.*, vol. ii. p. 49), who has taken the trouble to have the pulse watched carefully at this stage of the operation, it is not much affected to the touch, but a sphygmographic tracing taken in one case showed some irregularity during the necessary handling of the kidney, and increased arterial tension when the pedicle was ligatured. In my own experience, any alterations in the pulse are occasional only, and quite inconstant. Dragging on the pedicle is much more likely to produce shock.

Where it is certain that septic fluid from the kidney has entered a wound in the peritonæum, the surgeon should, after the operation is completed, make a small opening in the lower part of the linea alba, wash out the peritonæal cavity with boiled water, and place a drainage-tube in Douglas's pouch, this being regularly emptied as often as is requisite. Mr. Page, of Newcastle, adopted this plan in two cases, with entire success (*Lancet*, vol. i. 1893, p. 999).

The question may arise as to what is to be done if hæmorrhage still persists after the kidney is got out and its pedicle tied. Very few cases will occur in which ligatures cannot be applied to each bleeding point if the wound be well opened up, carefully dried, and if light be thrown down to the bottom. But when bleeding still goes on, Spencer Wells's forceps must be applied to the bleeding point and left *in situ* for two or three days, during which time they will also help to drain the wound. I have used this method twice with good results. If the forceps will not hold, careful plugging must be resorted to, strips of iodoform or sal alembroth gauze wrung out of carbolic acid lotion 1 in 20, the deepest attached to silk, and systematically packed into the bottom of the wound around a large drainage-tube till the wound is thoroughly filled; an external gauze dressing is then applied, and over this a firm but elastic padding of sal alembroth wool, which is kept *in situ* by firm bandaging. Mr. Clement Lucas (*Trans. Intern. Med. Congr.*, vol. ii. p. 271) nearly lost, from secondary hæmorrhage, a case in which nephrectomy had been successfully performed for suppurating tuberculous pyelitis. The bleeding came on about the fifteenth day, probably from the ligatures, which had been left long, being dragged upon. The hæmorrhage again occurred on the sixteenth day, when an attempt was made, after opening up the wound, to slip a ligature along the old ones, and thus to retie the pedicle. Hæmorrhage again occurring on the seventeenth day, and the patient being in a most precarious state, the wound was tightly and forcibly plugged with two large sponges steeped in perchloride of iron, and the abdomen bound firmly round with a flannel bandage. Morphia was given subcutaneously. About a week later the removal of the sponges, by cutting away the protruding part, was commenced, and this was completed by the end of another week. No bleeding recurred after the plugging, and the patient made a good recovery.

When all bleeding is stopped, a large drainage-tube should be inserted, with one end carried down to the very bottom of the wound, and the other cut almost flush with the surface. The wound is then partially closed with catgut and salmon-gut sutures, some iodoform dusted on, and aseptic dressings applied. If there has been much difficulty in getting out the kidney—and in cases of old inflammation it has to be dug out by touch, with very little help from sight—as in case No. 2, Table, p. 217—no sutures should be used, the wound being merely lightly plugged with iodoform gauze wrung out of carbolic acid lotion 1 in 20.

Dr. Weir, of New York (*Ann. of Surg.*, April, 1885, p. 311), during a nephrectomy in a young woman the subject of pyo-nephrosis, met with very severe hæmorrhage after ligature of the pedicle. This had apparently been effected with a single ligature. After removing the kidney, a gush of venous blood ensued, which was only partly arrested after repeated seizures with long pressure-forceps, but was finally controlled by

stuffing the wound full of sponges and turning the patient on her back. The shock was profound, and all the measures to produce reaction were resorted to. Transfusion performed twice to a total amount of 22 oz. gave rise at first to great improvement, but the patient died ten hours after the operation. The necropsy showed that the hæmorrhage came from a vein of considerable size, 1·5 centimetre above those secured by the ligature and forceps.

B. Nephrectomy by Abdominal Incision through the Peritonæum.

a. By Langenbüch's Incision at the Outer Edge of the Rectus.

b. By an Incision in the Linea Alba.

These two methods may be taken together. The former is the one most usually employed, as it has the following great advantages:—

1. The incision is nearer the vessels and ureter. 2. There is much less general exposure of the peritonæal sac (Knowsley Thornton). 3. The kidney is reached through the outer or posterior layer of the meso-colon, a step which avoids (*a*) hæmorrhage and (*b*) the risk of sloughing of the colon, as it is the inner or anterior layer—that between the colon and the middle line—which contains most of the vessels to the colon, and is especially rich in veins. It is this layer which is divided in the incision through the linea alba. 4. The operation can be rendered largely extra-peritonæal by having the inner edge of the cut meso-colon and that of the parietal peritonæum held in apposition or sutured with catgut.

Both operations give good room for necessary manipulations, both afford an opportunity for examining with the hand the condition of the opposite kidney.* After both, the wound can be drained posteriorly from the loin, but more easily after Langenbüch's incision.

a. **Langenbüch's Incision.**—The abdominal wall having been cleansed, an incision is made, at least four inches long at first, commencing just below the ribs, in the line of the linea semilunaris on the side of the disease, the centre of the incision being usually opposite to the umbilicus. The skin, subcutaneous tissue, and the aponeuroses at the outer edge of the rectus having been divided down to the transversalis fascia, and all hæmorrhage† having been carefully arrested, the transversalis fascia and the peritonæum are pinched up together, punctured, and slit up on a finger used as a director, the hand is

* I cannot but think that this advantage of the incisions through the peritonæum has been made too much of. In Mr. Barker's words (*Dict. of Surg.*, vol. ii. p. 48), "Though the hand may reach the kidney opposite to the one it is proposed to excise, its soundness or the reverse cannot be ascertained by mere palpation. Great enlargement, or, on the other hand, great reduction, in size, or complete absence, might be detected; but the organ might be tubercular, or fibroid, or contain a moderate-sized calculus, and yet the hand be unable to detect the condition." I have also referred to this matter, p. 186. Morris (*Diseases of the Kidney and Ureter*, 1901, vol. ii. p. 269) records an interesting case in which the opposite mistake was made. A surgeon, exploring through the right linea semilunaris, discovered what he thought to be a renal sarcoma. With his hand in the abdominal cavity he could not discover the left kidney, and he therefore concluded that the condition was hopeless. Later Morris was able to feel the left kidney by bimanual examination. The growth, which was successfully removed, was an ovarian dermoid.

† The amount of this, as will be familiar to all surgeons who have opened the peritonæal sac by this incision for intestinal obstruction, &c., varies a good deal. In the case of growth, large vessels are often present in the peritonæum over the kidney.

introduced, and the size of the growth and the condition of the opposite kidney investigated. In the case of a large growth the incision will now be enlarged, and any further hæmorrhage arrested. The growth, if large, is usually now seen in part. Any presenting intestine is turned over to the opposite side, and kept out of the way with a pad of aseptic gauze. The outer or posterior layer of the meso-colon will now probably present itself, pushed forward by the growth, which is often bluish-white in appearance and covered by large veins. The above-mentioned layer of the meso-colon is next torn through, either in a vertical or transverse direction, as will best avoid the vessels exposed. Any bleeding should be at once arrested by Spencer Wells's forceps and ligatures of fine silk. The intestines are then packed away with sterile gauze.

A sufficient opening having been made in the outer layer of the meso-colon, the fingers are introduced to examine into and further separate the connections of the kidney.

During all the necessary manipulations in the case of a growth, the greatest possible gentleness must be used so as not to rupture the capsule. In rapidly growing sarcomata, especially in children, the consistency may be jelly- or glue-like, and thus, if the capsule is opened, portions of the growth may readily be left behind. Again, hæmorrhage may easily follow this accident, and prove most embarrassing.* If the bleeding is of the nature of troublesome oozing it may be met by packing the cavity with iodoform gauze, the ends of which are brought out through a counter-incision in the loin. The wound in the peritonæum is next carefully sutured over the gauze, thus shutting off the abdominal cavity. The gauze may be removed in forty-eight hours (F. Page, *Lancet*, vol. ii. 1893, p. 1188). If the bleeding is from one or two points which cannot be tied, Spencer Wells's forceps may be left *in situ*, and removed in forty-eight hours.

The same precautions as to not damaging the capsule should be taken in the case of a kidney full of fluid. Where there is any risk of such fluid or of soft growth escaping into the peritoneal sac, sterile gauze should be carefully packed around, or the cut edges of the meso-colon and the parietal peritonæum united.

If the parts about the pedicle are free from adhesions, the vessels may be tied before the kidney is enucleated, which will render this latter step bloodless. Wherever it is possible, forceps should be placed on the vessels close to the kidney before they are divided, to save spilling of blood from the kidney; and where this contains pus, the same precaution should be taken with the ureter.

The vessels should be tied with the precautions given above (p. 206). All dragging on the pedicle should be scrupulously avoided.

The kidney being removed, the site of the operation is most carefully

* Thus it has even happened to Prof. Czerny, whose experience in nephrectomy is almost unrivalled, to be driven to tie the abdominal aorta. The profuse hæmorrhage met with in removing a large growth of the left kidney could only be stopped by pressure on the abdominal aorta. This vessel was accordingly tied. Death took place ten hours later. It was found that the renal artery had been torn through at its entrance into the tumour. The ligature on the aorta had been so placed that, while the blood-supply through the left was cut off, the right vessel was pervious.

cleansed and dried. If troublesome oozing has occurred and is at all likely to persist, a large drainage-tube had best be passed out through the loin by pushing a short pair of dressing-forceps from the site of the kidney so that it bulges in the loin, where it is cut down upon, and used to seize the tube. It has been suggested that the divided edges of the meso-colon may be united with a few points of catgut suture, but this precaution does not seem to be absolutely needful, as the edges usually fall readily into apposition.

Mr. Knowsley Thornton lays stress upon his method of treating the ureter. This tube is taken last in the enucleation of the kidney, "and, before separation, its renal end should be secured by pressure-forceps, then a ligature tied a little way from the forceps, and a sponge placed under it before it is divided. Whenever it is possible, I enucleate it for some distance from the kidney before dividing it, so that its cut end, with the sponge under it, may be at once drawn outside the abdomen; and afterwards fix it in the lower angle, or most convenient part of the abdominal incision, with a cleansed safety-pin. I regard this fixing out of the stump of the ureter as the most important detail in the operation, and in every case in which I have been obliged to cut it off deep in the wound I have had distinct evidence of suppuration and trouble around it." Mr. Thornton considers the objection that this method risks the occurrence of future intestinal obstruction an entirely fanciful one. At the worst, a ureter so treated is only a slight ridge over a small surface of the abdominal wall, quickly disappearing by atrophy. Other surgeons, who have treated the ureter by ligature and dropping it in, have not met with the results of suppuration and sloughing which Mr. Thornton thinks are very likely to follow on this course. The only after-trouble which I have known the ureter to give is in cases of removal of tubercular kidney. Unless this operation is performed at a very early stage, there must always be a great risk that, owing to the ureter having become involved, the mischief will spread to the bladder.

Ramsay (*loc. supra cit.*) discusses the mode of dealing with the ureter in tuberculous cases at some length, and quotes Regnier as having removed a tuberculous ureter some months after the nephrectomy. Kelly, in the *Johns Hopkins Bulletin*, March, 1896, reports three cases in which he removed the whole of the tuberculous ureter with success at the time of the nephrectomy. On the other hand, there is evidence to show that tuberculous disease of the ureter tends to undergo a process of cure after nephrectomy. One case in point is that of Tilden Brown (*Ann. of Surg.*, 1899, vol. i. p. 755). Here the kidney was removed and the ureter left behind. At the necropsy, some months later, the ureter, previously as thick as the thumb, had diminished to one-fourth its size.

Ramsay's conclusions on this point are as follows: "It is safest to remove the ureter with the kidney, as a persistent fistula may give trouble if it is allowed to remain in the body;" and again, "that a certain proportion of these fistulæ will finally disappear, either after the removal of a deep suture, or because of the slow disappearance of the tubercular disease in the ureter, which, in these cases, gradually changes into a fibrous cord."

b. Nephrectomy by an Incision in the Linea Alba.—For reasons already given, p. 209, this method is not recommended, that of Langenbüch, already fully described, being preferable.

The incision in the linea alba will not materially differ from that for ovariectomy or abdominal exploration, and the same precautions are called for in removing a kidney by this method as in that through the linea semilunaris.

C. Nephrectomy through the Abdominal Wall, but without opening the Peritonæum.—Having made use of the method in one case nine years ago, and being much struck by the room afforded, I may make brief mention of it:

The patient was a woman, aged 54, the subject of a movable kidney on the right side, the kidney being also the seat of malignant disease. As the abdominal walls were thin, and as the kidney could easily be made to project in the anterior part of the right lumbar region, I made a longitudinal incision from the anterior superior spine up to the eighth rib. The different layers were cut through, very little hæmorrhage being met with; when the peritonæum was reached, this was then stripped up out of the iliac fossa, upwards and inwards, then upwards off the anterior surface of the kidney until its vessels came in view. No difficulty was experienced in dealing with the pedicle—first the ureter, and then the vessels. The vena cava was seen for about $1\frac{1}{2}$ inch receiving pulsation from the aorta. The patient never rallied thoroughly from the operation,* and sank about twenty-four hours after. The necropsy showed ligatures firmly tied; one of those on the renal vein had slightly puckered in the inner surface of the vena cava. A clot the size of the little finger constituted all the bleeding that had taken place. The kidney was, save for one small patch at the lower part, entirely converted into encephaloid carcinoma. Two or three of the aortic glands were enlarged; there were no other secondary deposits.

Paterson (*Lancet*, vol. i. 1903, p. 729) publishes an account of a similar operation and strongly recommends it; his patient was well $4\frac{1}{2}$ years after the removal of a carcinomatous left kidney; there was no sign of a ventral hernia.

Treves is probably right in believing the risk of ventral hernia to be considerable after this operation.

D. Combination of Lumbar and Abdominal Nephrectomy.—Dr. Hume, of Newcastle, made use of this method in a case of sarcoma (*Lancet*, vol. i. 1893, p. 196):

An incision about six inches long was first made in the linea semilunaris, and the swelling found to be in the left kidney. A lumbar incision was then made from the middle of the first cut, dividing all the structures forming the abdominal wall, including the peritonæum. The intestines were pushed to the right and protected with sponges. The peritonæum covering the kidney was then separated until the whole growth was exposed. The large cavity left was plugged with sublimate gauze dusted with iodoform, the ends of the strips being brought out through an opening in the most dependent part of the loin. The strips were removed in thirty-six hours. The patient recovered.

E. Morris' (*Surgical Diseases of the Kidney and Ureter*, vol. ii. p. 250) Combined Method has been described briefly at p. 200; he recommends it for the removal of renal growths.

F. Mr. Knowsley Thornton's Combined Method.—This is given at p. 184.

a. Choice between Lumbar and Abdominal Nephrectomy.—While it is certain that all kidneys of small or moderately large size

* I think that the thinness of the abdominal walls prolonged the operation, owing to my anxiety not to wound the peritonæum. As has been said above, the hæmorrhage was very slight, and I was careful not to pull upon the pedicle.

can be easily removed by a lumbar incision sufficiently enlarged (p. 173), time alone will show whether I am right in my opinion that before the lumbar method is abandoned a trial should be made of such a free incision as König's (p. 205) when large kidneys have to be attacked. And this leads to the question of chief importance: How far is the danger really increased by going through the peritonæum to get at the kidney? I am strongly of opinion that, in spite of all the recent improvements in abdominal surgery and their success in preventing *peritonitis*, interference with and handling the contents of the peritonæum, save in the shortest and simplest instances, remains, on the score of *shock*, as grave a thing as ever it was. I am quite aware that, in the hands of a few operators, such as the late Sir S. Wells, Mr. K. Thornton, and Mr. Malcolm, removal of kidneys, even in difficult cases, through an abdominal wound involving the peritonæum, has given excellent results—results perhaps as good as, or better than, those by the lumbar method. But, while allowing this, it cannot, I think, be lost sight of that the kidney is an extra-peritonæal organ, not one, like the uterus and ovary, within the peritonæal sac. It will assuredly never come about that removal of the kidney will pass, like oöphorectomy and removal of the uterus or its appendages, into the hands of a few operators, however specially skilled in abdominal surgery. This being so, and the organ in question being one behind and outside the peritonæum, while each man will decide for himself and according to his special experience and line of work, the majority of surgeons will, I think, prefer to make their attacks from behind whenever this is possible. This question is also dealt with above (pp. 187 and 200).

LUMBAR NEPHRECTOMY—ADVANTAGES:—1. The peritonæum, save in cases of exceptional difficulty, is not opened or contaminated. 2. Efficient drainage is easily provided. 3. The structures interfered with are much less important. 4. As pointed out by the late Mr. Greig Smith, "in the case of its being unwise, as in abscess, or in tumour affecting the surrounding tissues, to proceed to removal, it is less serious to the patient." 5. If the kidney is firmly matted down, as in the cases given at p. 204, such dense posterior adhesions are most readily dealt with by the lumbar method. 6. The lumbar incision, if converted into a T-shaped one, or prolonged forwards by König's method, will give sufficient room for meeting most of the conditions which call for nephrectomy. Thus modified, it will suffice for new growths.

LUMBAR NEPHRECTOMY—DISADVANTAGES:—1. It is thought by some that too little room is given by this method for the removal of large kidneys. It has already been shown (p. 173) how extensively this incision can be enlarged. It is doubtful, therefore, if this objection holds good for any cases, even those of unusually long-chested patients, or those with spinal deformity. 2. In a fat subject the organ may be difficult to reach, even when well pushed up from the front, owing to the great depth of the wound. 3. The pedicle is less easily reached,* and thus, in cases of difficulty, bleeding at a very important stage of the operation is less easily dealt with. 4. If the kidney be very adherent, important structures—*e.g.*, the peritonæum and colon—may be opened, unless great care is taken. 5. The condition of the opposite kidney

* This objection and the next can be met by a very free incision (p. 205).

cannot be examined into. Possible fallacies here have been pointed out, pp. 186, 209.

NEPHRECTOMY BY ABDOMINAL INCISIONS IN THE LINEA ALBA, OR AT THE EDGE OF THE RECTUS, THE PERITONÆAL CAVITY BEING OPENED—ADVANTAGES:—1. Additional room in case of large kidneys. 2. More easy access to the pedicle, the vessels of which can be tied early in the operation to lessen hæmorrhage during enucleation; this is, however, not always possible, for large growths may overlap the vessels, and in inflammatory cases, there may be much confusion from matting and adhesions. 3. The possibility of examining the condition of the other kidney. It has already been pointed out (pp. 186, 209) that this advantage is probably overrated. Thorough examinations along the lines laid down at p. 149 are far more reliable, for a kidney which may seem to be normal to the touch, may be insufficient after the other is excised. 4. The extent, the presence or absence of secondary growths, and the wisdom or otherwise of attempting nephrectomy can be decided early in the operation. 5. The diagnosis can be made between renal enlargements and others arising in the colon or liver.

NEPHRECTOMY BY ABDOMINAL INCISIONS THROUGH THE PERITONÆUM—DISADVANTAGES:—1. The peritonæal sac is opened. 2. The same sac may be seriously contaminated if a kidney containing septic matter, or one largely converted into soft growth, is ruptured during the needful manipulations. 3. The intestines may be difficult to deal with, and may, by crowding into the field of operation and the incision in the abdominal wall, prove most embarrassing. 4. The handling and interference with the contents of the peritonæum may cause considerable shock. 5. The vitality of the colon may, by interference with its blood-supply, be endangered. 6. It is more difficult, by this method, to deal with any dense adhesions which may exist behind the kidney. 7. If bleeding follow the operation, reopening an abdominal wound, finding the bleeding points and securing them, or plugging the wound, will be attended by more shock than the adoption of the same course by the lumbar method. A case supporting this view is candidly reported by Mr. Page, of Newcastle (*Lancet*, vol. ii. 1893, p. 1187). 8. Efficient drainage is less easily provided in cases of any contamination of the peritonæal cavity, or of oozing after the kidney is removed. 9. The after-complication of a ventral hernia is much more probable by this method, though it must be allowed that the free lumbar incision already alluded to may be followed by the same result.

Morris, with all his experience (*loc. cit.*) advocates the use of the lumbar operation for all cases except for tumours of very large size, injuries of the kidney which may be complicated by other injuries within the abdomen, and the rare cases in which a kidney really floats in the peritonæal cavity anchored only by its pedicle, which is surrounded by peritonæum. He states that "the lumbar operation ought not to be regarded merely as the operation of choice; with the exceptions stated, it is the only operation which ought to be considered justifiable. The kidney as an extra-peritonæal organ ought to be attacked from behind, and not across the peritonæal cavity."

Causes of Death after Nephrectomy.—1. Shock.—This may be induced by hæmorrhage, much traction on the pedicle, and thus, probably, interference with the solar plexus, injury to the colon, and,

where the peritonæal sac is opened, by much disturbance of its contents.

2. Hæmorrhage.—This is especially to be dreaded where the pedicle is deep and difficult to command; where there are aberrant renal vessels; where these vessels are enlarged and perhaps softened; where, owing to too much tension on the pedicle, a vessel retracts from within its loop of ligature; where the kidney capsule and tissue are broken into. In the intra-peritonæal method there is the additional danger of enlarged veins within the meso-colon. Secondary hæmorrhage has been alluded to above, pp. 206, 208.

3. Uræmia and Anuria.—These are only likely to occur when it has been impossible to form a correct estimate of the condition of the opposite kidney, or where, to give a patient a chance, the surgeon operates in what he knows to be a doubtful case. Where there is reason to believe that the suppression of urine may be due to a calculus in the opposite kidney, this should at once be cut down upon in the hope of finding a calculus that can be removed. Mr. Lucas's brilliant example of what nephro-lithotomy may do, when such peril sets in at a later date, has been referred to at p. 193.

4. Peritonitis.—This, if septic, is due either to mischief introduced at the operation or from the kidney. While it is certainly more likely to follow the intra-peritonæal operation, it may occur after that through the loin, especially when much difficulty is met with here, owing to numerous adhesions, or to working in a wound of insufficient size.*

5. Septic trouble—Cellulitis—Erysipelas—Pyæmia.—These are especially likely when the kidney contains septic matter, when the soft parts are much bruised, or when many fingers enter the wound. Other, rarer, causes of death are—

6. Pulmonary Embolism.

7. Empyema.—This may be brought about by an extension of septic cellulitis, or by removing, during the operation, a portion of rib in order to get more room—a step the danger of which cannot be too strongly enforced (p. 180). An anatomical predisposition favouring the passage of inflammation from the kidney to the pleura has been pointed out by Dr. Lange, of New York. This authority on renal surgery found, in one subject, an enormous gap in the diaphragm, the muscle fibres being absent from the ligamentum arcuatum internum as far as the outermost part of the eleventh rib. Between these two points the fibres of the diaphragm communicated in a high arch, bounding an area in which the fatty tissue about the kidney was in direct contact with the pleura.

8. Intestinal Obstruction.—This occurred fatally in one of Mr. Thornton's cases. He thought it was brought about by his suturing the two edges of the peritonæum over the kidney together, and thus producing kinking of the large intestine.

Partial Nephrectomy.—This has been rendered justifiable by the results of experiments on animals. Morris (*loc. supra cit.*) says, "Tuffier's experiments on animals, in 1888, and Barth's histological researches supply ample proofs of the healing power of the kidney,

* During a nephrectomy for pyonephrosis the peritonæum was injured owing to the adhesions of the renal capsule. As it was thought certain that some septic fluid had escaped into the peritonæal cavity, this was opened by a small incision above the pubes after the lumbar wound had been closed. Some ounces of bloody fluid escaped, the cavity was washed out, and a drainage-tube placed in Douglas's pouch. The patient recovered. (F. Page, *Lancet*, vol. i. 1893, p. 999.)

and the process by which healing is accomplished, even after extirpation of considerable portions. Paoli, of Perugia, performed extra-peritoneal operations for resection of the kidney upon twenty-five dogs, cats, and rabbits, with perfect recovery."

Morris records 10 cases of partial excision for disease—tuberculous foci, traumatic abscess, containing a secondary calculus, a cyst, and a fistula—he has excised up to nearly one-half of the kidney for tubercle.

All the 10 cases recovered from the operations but one required total nephrectomy a week later for acute general pyelo-nephritis, and died 3 months afterwards from general tuberculosis. Another needed nephro-ureterectomy 7 months later, and in another symptoms returned within a year. The rest were well in 1900 except one who had died of acute broncho-pneumonia 3 years after the operation.

Morris also gives a *resumé* of eleven operations (from foreign literature), three for cysts, three for calculous pyonephritis, two for new growths, and one each for puerperal pyonephritis, renal fistula, and a patch of interstitial nephritis mistaken for malignant disease.

None of these cases died; nine made good recoveries, one required nephrectomy, and in one fistula resulted.

Ramsay (*loc. supra cit.*) mentions nine cases of partial nephrectomy for tuberculous disease; in only two of these, however, was the result satisfactory. One, reported by Israel, was well one year later; the other, by Morris, was well two years later.

This operation may also be performed in cases of laceration of the kidney by injury, where the greater part of the organ is uninjured. Here the organ will very likely be healthy, and removal of an almost detached part may be sufficient to arrest the hæmorrhage. Mr. Keetley has recorded a case of this kind (*Lancet*, vol. i. 1890, p. 134):

A young man had been crushed by a waggon-wheel. There was laceration. Five or six hours after the accident he showed signs of serious recurrent hæmorrhage. Through an incision a mass of blood-clot was scooped out, also the separated lower end of the kidney, a deep bleeding point being compressed with sponges, which were removed in twelve hours. Convalescence was rapid. No urinary fistula or hydro-nephrosis resulted.

It may be said, therefore, that where, on examination of the kidney, a suitable opportunity presents itself, partial nephrectomy may be performed, and the greater part of the kidney in this way saved. The wound in the kidney may be sutured or the hæmorrhage may be arrested by means of plugging with iodoform gauze, suturing being the preferable method where possible; for in this way both hæmorrhage and escape of urine will be prevented, and rapid healing of the whole wound thus secured.

In view of the unsatisfactory results, with a few exceptions, that have attended this method of treating tuberculous disease, and of the great difficulty there must be in making certain that all disease has been removed, it would seem wiser to remove the entire kidney in such cases if the opposite organ is known to be healthy. Hurry Fenwick (*Med. Ann.*, 1906, p. 296) states that he would only be content with a resection when "the disease was evidently limited to one pole as demonstrated by slitting the organ from end to end and down into the pelvis,"

No.	By whom sent.	Sex.	Age.	Disease.	Result.
1	Dr. Moxon.	F.	45	Carcinoma.	Death, about thirty hours after, from prolonged shock. This kidney, though greatly enlarged, was got out through a very free lumbar incision by tilting its long axis into that of the wound. I see now that I took up too much time in tying every small vessel as I went along. Two of the glands on the vena cava were carcinomatous.
2	Mr. E. O. Day.	M.	27	Very long standing pyelitis; drainage.	Recovery. This patient had had cystitis nearly all his life. Eight years before, he had been cut for vesical calculus in Nottingham. He was sent to me in a state of septicæmia, due to a most foul pyelitis. This was drained, but a sinus persisted, and fourteen months later I removed the kidney. This was very small, and so universally and firmly adherent that it had to be literally dug out by the finger. The man had constant hiccough for a fortnight, possibly due to some injury to the phrenic or the diaphragm.
3	Dr. F. Taylor.	F.	42	Tubercular pyelitis.	Recovery. She is alive eight and a half years later, with no irritability of the bladder, and passing no pus.
4	Dr. Phillips, Bedford.	M.	—	Tubercular pyelitis.	Recovery, eleven years ago. He completed his terms at Cambridge and took curacies. Fourteen months after the operation he began to show signs of tubercular mischief in the prostate and vesiculæ seminales. A little later he, most unwisely, married. Two children were born, each quickly dying. When last heard of, nine years after the operation, he was holding a chaplaincy abroad; a sinus had apparently formed in connection with the stump of the ureter.
5	Dr. Phillips, Faversham.	F.	3	Sarcoma.	Recovery from operation. Death two months later. The renal vein was found thrombosed with growth at the operation.
6	Dr. Perry.	M.	2½	Cystic disease, congenital.	Recovery.
7	Dr. G. Newton Pitt.	M.	30	Calculus pyelitis.	Recovery. A year before, I had performed nephro-lithotomy and removed eight stones. A most fetid sinus persisted, kept up by a phosphatic stone, which I had left behind in the upper end of the kidney.
8	Dr. F. Taylor.	F.	18	Tubercular pyelitis.	Recovery. The kidney had been explored and drained six weeks before.
9	Dr. J. B. Howell, Wandsworth.	F.	23	Pyonephrosis; no cause was made out.	Recovery. The kidney had been explored and drained five months before.
10	Dr. B. Scott, of Bournemouth.	F.	34	Hydronephrosis.	Recovery. In this case there had been colicky pains and frequent micturition, simulating calculus, for three and a half years. A swelling had been noticed for a few months. This was first drained, and, three months later, the kidney was removed.

LUMBAR NEPHRECTOMIES—(continued).

No.	By whom sent.	Sex.	Age.	Disease.	Result.
11	Dr. G. Newton Pitt.	F.	26	Tubercular pyelitis.	Recovery. T. bacilli in urine. Kidney when removed in an advanced stage of caseation and excavation. Two sinuses remained here which closed firmly after being scraped out. Owing to presence of vesical pain and inability to hold water, AgNO_3 3 <i>j</i> -3 <i>j</i> . was applied to mucous membrane of the bladder. As a result the patient was able to hold her water for three hours. It is to be feared, however, that the disease in the kidney had lasted too long, and that in the bladder was too advanced to admit of a permanent cure. The disappearance of hectic and the gain of flesh were, however, very marked after the nephrectomy.
12	Dr. F. Taylor.	F.	22	Tubercular pyelitis. Tubercle bacilli found in the urine.	Recovery. Previous drainage. Removal of kidney a month later. Two and a half years later patient reports herself as "in the best of health."
13	Dr. Luscombe, of Tickenham.	F.	34	Tubercular pyelitis.	Recovery. Drainage of the kidney and, at the same time, removal of a calculus from the ureter one a half inches below the pelvis. Removal of kidney three weeks later. Severe parotitis three weeks afterwards, requiring incisions. I saw this patient three years afterwards. She was well and strong, and had borne a healthy infant.
14	Dr. F. Taylor.	M.	18	Hydronephrosis.	Recovery. Frequent pain in left side, alternating with vomiting. Kidney dilated into a very large sac, extending up under ribs. Removal without previous drainage. Small part of the cyst left behind for security of ligatures. The hydronephrosis was probably due to an abnormal arrangement of the renal vessels, and thus pressure on the ureter.
15	Dr. Sandoe, of Broadclyst.	M.	35	Tubercular pyelitis.	Recovery from the operation. Patient had had one foram amputated for "strumous disease of wrist." Admitted for perinephritic abscess. This was drained. A month later the kidney was removed. The presence of tubercle bacilli continued in the urine. The wound was not quite healed when the patient left, and he died from exhaustion and failure of the other kidney two months after leaving the hospital.
16	Dr. Blood, of Birkenhead, and Dr. Goodhart.	F.	31	Tubercular pyelitis. No bacilli found.* A sister died of pulmonary phthisis.	Recovery. The kidney showed most extensive caseation and early vomice. I have seen this patient recently, nearly five years after the operation, and her health is excellent.
17	Dr. Whitthoff, of Brighton, and Dr. Goodhart.	M.	14	Tubercular pyelitis, and probably early cystitis.	Recovery. The kidney here was greatly enlarged. Fortunately it was not very fixed. It was got out through a lumbar incision much prolonged, and T-shaped. About six months later I had to scrape out two sinuses, probably connected with the stump of the ureter, which was in a state of advanced disease. About three years after the nephrectomy, castration was required for tubercular disease of one testicle, and a little later he was placed under my care again for a sinus connected with the castration wound. The cut end of the vas was found to be tubercular and was freely removed. All has been soundly healed for nine months, but the outlook is very gloomy.

* I was informed of the result, the examination of the kidney having been made at Liverpool.

LUMBAR NEPHRECTOMIES—(continued).

No.	By whom sent.	Sex.	Age.	Disease.	Result.
18	Dr. Galabin.	F.	38	Carcinoma.	Recovery from operation. Here there was some question whether the large kidney would come out through a lumbar incision. This was effected by a very free incision and tilting the long axis of the kidney into that of the wound. The patient died five months afterwards of secondary deposits.
19	Dr. Halsead, of Ramsgate.	M.	57	Hydronephrosis. No previous drainage.	Recovery. Here a sinus persisted for over a year after the nephrectomy, due to a piece of silk. I have seen this patient lately, four years after the operation, in excellent health.
20	Accident, Guy's Hospital.	M.	13	Laceration of kidney. Other injuries.	Death. This patient was in a most grave condition when I was asked to see him. Forty-eight hours before, a van-wheel had passed over his abdomen and chest. Hamaturia had been constant, profuse, and accompanied with clots. The region of the right kidney was occupied by a very tender swelling. The patient was delirious, due, I thought, to absorption from the breaking down clots, and the pulse scarcely perceptible owing to the hamaturia. To give him a chance I performed nephrectomy, which was as simple as possible. The kidney was found torn in half, one part being connected with the ureter, the other with the vessels. Transfusion was performed, but nephrectomy came too late, and the patient sank a few hours later. The necropsy showed bruising of the liver, some blood in the peritoneal sac, which was uninjured, and much effused around the cæcum and ascending colon.
21	Dr. F. Taylor.	F.	35	Calculus pyelitis. Bilateral.	Death. At the time of the nephrectomy, one large irregular calculus and several small faceted ones were removed from the right kidney. As this was much enlarged, its cortex indurated, pale, and atrophied, it was removed. Three days later it is noted that thirty-six ounces of urine were passed in the previous twenty-four hours. This quantity gradually lessened, sickness gradually increased, and the patient sank fifteen days after the operation. The necropsy showed that the left kidney was also the seat of hydronephrosis, and the ureter here occupied by a calculus.
22	Royal Hospital for Children and Women.	F.	21	Tubercular pyelitis.	Death. Eight years before, I had excised the right knee-joint of this patient. The right kidney was greatly enlarged and much thickened, there being but little pus in proportion to the advanced caseation. It was extremely adherent, especially above, under the diaphragm. Towards the close of the operation, as I was clearing the pedicle, which was much overlapped by the enlarged kidney, I wounded the vena cava. The opening was properly clamped and ligatures placed above and below. The operation was most difficult throughout, and accompanied by much shock. Transfusion was resorted to, but the patient sank three hours later.
23	Dr. Brogden, of Ipswich.	F.	23	Pyonephrosis.	Recovery. Pain had existed in the right kidney for eight years. Nephrography and, later on, nephro-lithotomy (three oxalate calculi had been removed), had been performed by Dr. Brogden, with great relief for some years. The kidney was much dilated, with a very wasted cortex. Three oxalate calculi were found in the upper and two in the lower end, all very minute and in dilated calyces.

Results of Nephrectomy.

The foregoing list shows twenty-three cases with four* deaths. Tubercular cases, where the mischief is advanced and the adhesions extensive, as in case 22; malignant growths; and cases of calculous pyelitis where both kidneys are affected, though one only at the time of operation may contain stones, will always keep up the mortality of nephrectomy.

Mr. H. Morris (*Surgery of the Kidney and Ureter*, vol. ii. p. 275) gives the following statistics of his cases: (a) In twenty-nine nephrectomies for calculous disease, there were five deaths; (b) in twenty-four nephrectomies for hydro- and pyonephrosis there were three deaths; (c) in twenty-two nephrectomies for tuberculosis there were five deaths; (d) in seventeen nephrectomies for tumour there were four deaths; (e) in three nephrectomies for fistula there were no deaths. Thus, there were seventeen deaths out of ninety-five cases.

Tuffier's statistics published in 1899 give a mortality of 28·4 per cent. in 200 lumbar nephrectomies, and 44·1 per cent. in 161 transperitonæal nephrectomies.

NEPHRORRAPHY OR NEPHROPEXY.

It is well known that nephrorraphy has not always been followed by the relief expected. This, I think, is due to one or more of the following causes:

1. The operation has been performed in unsuitable cases. (A.) Cases where the mobility of the kidney is only, in reality, a small part of the trouble. Well-marked instances of this group would be those cases where mobility of the kidney co-exists with a markedly neurotic tendency, a group in which, were it not for the above tendency, the mobility of the kidney would be little complained of; a group in which operation has been resorted to far too often, thus bringing much discredit upon it; a group, finally, in which nephrorraphy is rarely to be resorted to, and then only with the greatest caution.† In dyspeptic, neurotic women approaching the menopause the operation should be avoided altogether. In the neurotic tendency lies one of the chief difficulties with regard to making a decision on the question of operation. The frequency with which a highly nervous temperament is present suggests the obvious question, Would these symptoms have arisen were it not for the neurotic tendency? Any honest medical man would answer that in the majority they would not. In a certain number the mobility of the kidney determines the region and distribution of the neurotic trouble; in a very few it originates and causes the neurotic tendency.‡ Care should be taken not to attribute to a

* I have included No. 20, as I performed the nephrectomy. The case was, however, admitted under the care of another surgeon, and I was only called to it at the very end. On the other hand, case 15 ought, perhaps, to be accounted a fatal case of nephrectomy.

† In an interesting paper by Dr. Drummond (*loc. infra cit.*), thirty cases of movable kidney are given, two of which were treated by nephrorraphy. Both relapsed. In a third case, the details of which were supplied to Dr. Drummond, "excision of the movable kidney was practised without any relief."

‡ As in the rare cases where a man, previously active and healthy, has his life spoilt and becomes hypochondriacal after one kidney has become movable.

movable kidney symptoms really due to other causes, such as dyspepsia, appendicitis or gall stones, for it is certain that many healthy women have freely movable kidneys. Larrabee (*Boston Med. and Surg. Journ.*, Nov. 26, 1903) examined 272 women for movable kidney, and found it in 112 or 41·5 per cent.; in 39 it was merely palpable on deep inspiration; in 49 it could be kept down during expiration; in 24 it could be pushed about freely; in 40 cases there were no symptoms; and in 66 some loss of weight; only 6 patients gave a history of "Dietl's crises."

Gordon (*Lancet*, 1903, vol. i. p. 1587) relates an interesting case in which a movable kidney was thought to be the cause of indigestion, constipation, and attacks of pain in the right side. Nephropexy failed to give relief, and later a simple stricture of the sigmoid flexure was discovered during an exploration for intestinal obstruction which proved fatal.

Again, where the mobility of the kidney is associated with a general ptosis of the viscera, especially of the liver, with long-standing dyspepsia or constipation, or with uterine or ovarian trouble, it will be useless to perform nephrorraphy, unless the other ailments can be corrected—a matter of no little doubt and difficulty in some of those patients in whom we meet with this disorder. (B.) In a certain proportion of movable kidneys—and this, perhaps, a larger one than is usually allowed—organic disease coexists as well. I have met with three such cases. In one (Case 1, Table, p. 217) the kidney was the site of carcinoma; in a second (Case 8, *loc. supra cit.*), early tubercular disease must have been present. About two months after the nephrorraphy, pain having returned, further examination showed that the urine, which had before been found normal, contained pus. At a second operation two early foci of tubercular suppuration* were found and the kidney was removed. Six years later the patient was alive and well. The third case was one associated with hydronephrosis. At this time, when performing nephrorraphy, I was passing my sutures through the tissue of the kidney itself, a method which I now consider quite unreliable, and I am doubtful if the relief given in this case of hydronephrosis was permanent. The question of nephrorraphy in hydronephrosis is referred to below.

Mr. F. E. Taylor (*Ann. of Surg.*, 1904, vol. xl. p. 215) records five cases in which unsuspected lesions were discovered during the operation of nephropexy. Three of these cases occurred in a series of thirty hospital patients. Renal calculi were discovered and removed in two cases, and tuberculous disease in two others, in one of these partial nephrectomy of the lower pole was performed, and in the other nephrectomy was necessary. The fifth case was one of hydronephrosis associated with movable kidney, and probably due to the mobility.

Taylor concludes that an operation is indicated when "some unusual

* My silk sutures, with which the kidney had been fixed, were found *in situ*, but as the collections of pus were on the inner aspect of the kidney, I do not think they dated to the stitching, in which the kidney substance had been boldly taken up. The early appearance of pus after the nephrorraphy is, however, suspicious, and it is quite possible that in delicate patients the injury inflicted by suturing might be the starting-point of tubercular disease of the kidney.

or unexplained symptom is present, and still more if any tenderness or enlargement of the kidney can be made out." He also pleads for a more thorough examination of the kidney during the operation, and that the organ should always be brought outside the loin and carefully palpated and inspected, and even incised if any doubtful spot is discovered.

2. Another frequent cause of nephrorraphy failing to give permanent relief is the way in which the operation is performed. Too much reliance has been placed on removing some of the fatty capsule and suturing its edges to the lips of the wound with gauze packing, but without passing any sutures through the fibrous or true capsule of the kidney. A little experience was sufficient to convince Hahn that this method which he introduced was insufficient. Frequently the kidney is already movable within this capsule, and no good results; and where no such mobility has existed, the loose fatty tissue, however carefully pulled out, tightened and stitched, gradually stretches and ceases to fix the organ. In other cases—and this is very frequent—the kidney tissue itself is deeply traversed by the needle. Now, the friability of the kidney is well known. Every operator who has passed sutures in this way is familiar with their tendency to cut through before or just as they are finally tightened and tied. So soft is the tissue of the kidney, especially when injured and inflamed—as around a suture—that I believe that, even when silk sutures thus passed have been left *in situ*, their cutting through is only a matter of time. When unsuitably prepared catgut, however stout, has been employed the result is still worse. Like silk, it is very liable to cut its way through the easily lacerable kidney tissue as it is tied; if it does not do so then its softening takes place so quickly in the vascular kidney tissue that any permanent anchoring by the blending of this material with other tissues is impossible.* Moreover, there is another danger, not altogether a fanciful one, which may follow on deeply puncturing the kidney. A German surgeon, Barth, has seen a necrotic centre caused in the kidney owing to the occlusion of one of the arterial centres by the anchoring suture. A similar condition has been noted as the result of puncture. One of the large arteries was obstructed, hæmorrhagic infarction took place, and ultimately necrosis (M'Ardle, *Brit. Med. Journ.*, vol. i. 1894, p. 526). A fourth step that has been advised, scarifying the surface of the kidney and scraping the adjacent muscles and fasciæ does not commend itself to me as satisfactory at the time or likely to be of permanent utility later. Sometimes the kidney is fixed too low down, hydronephrosis or pyonephrosis resulting. Mr. Bruce Clarke (*Lancet*, 1905, vol. i. p. 8) records an interesting case of this kind in which the kidney had been fixed so low that it nearly touched the crest of the ilium. Hydronephrosis developed and Mr. Bruce Clarke replaced the kidney after proving that there was no obstruction in the ureter. The kidney was regaining its normal secreting power, and the patient was comfortable when last seen a few weeks after the operation.

* Dr. Newman drew attention to this fact several years ago (*Lects. on the Surg. Dis. of the Kidney*, p. 69): "The sutures passed into the kidney became destroyed more rapidly than elsewhere; the living renal tissue seems to have an unusual power of absorption."

Indications.—To speak of the indications more exactly. Where an otherwise healthy kidney is very movable, especially where this dates in sensible people to an injury, if the surgeon is in doubt as to an operation, he should try and satisfy himself that other treatment, including a sufficient trial of a well-fitting apparatus,* has failed, that the pain, whether constant or paroxysmal, is *bonâ fide*, and that it really cripples and spoils the patient's life. Constipation and dyspepsia will of course have been treated, tight lacing given up, and a trial made of a well-fitting truss or belt, or a corset coming low down in front and so fitted as to gather up the lower part of the abdomen and its contents. Gallant (*Inter. Journ. of Surg.*, Feb., 1903) strongly recommends a corset of this kind. Thus, conditions of movable kidney which call for operation are:

1. Frequent, severe, and spasmodic attacks of pain, or more or less continuous suffering (Morris, vol. ii. p. 221).

2. Dietl's "crises" consisting chiefly of violent attacks of colic, nausea and vomiting, tenderness and distension of the abdomen, and sometimes shivering and rise of temperature. These attacks may be due to torsion of the vessels or nerves of the pedicle or of the ureter, or of the duodenum. Obstinate constipation due to kinking of the colon is sometimes relieved by fixing the kidney.

3. Renal paroxysms of acute abdominal pain, rigidity of the abdomen over the kidney, "faintness, giddiness, and other symptoms of collapse" (Morris). These rare attacks are probably due to "acute renal dislocation" (Lancereaux), and torsion of the pedicle.†

4. Another strong indication for nephrorraphy is early hydronephrosis. Here the operation is resorted to not only to save the patient from the pain caused by the movable kidney, but to "prevent the organ from bringing about its own destruction" (Lucas). Mr. Lucas (*Brit. Med. Journ.*, vol. ii. 1891, p. 1344) relates four cases in which mobility of the kidney allowed of displacement of the organ on its transverse axis, causing bending of the ureter,‡ and thus distension of the pelvis with urine. Two of the cases were treated by nephrorraphy, and when last seen remained cured. One of the cases, in which the hydronephrosis was undoubtedly due to the displacement, seemed to

* The best one that I know is the one recommended by Sir Frederick Treves (*Pract.*, Jan., 1905) and made by Ernst: "It consists of a thin, carefully-padded metal plate, which exercises pressure upon the abdominal wall by means of two springs. The pressure concerns the lower and inner margins of the plate, so that the kidney is forced upwards and outwards." Since 1895 Treves has used the instrument for over 300 private patients, in 95 per cent. of whom "the truss has proved absolutely efficient." "With the truss on the patient has been able to take active exercise, to ride, and in an occasional instance, to hunt." The instrument must be very carefully fitted, and must be applied when the patient is lying down.

† Dr. Weigall (*Australasian Med. Gazette*, Nov., 1903) has published a most remarkable case of gangrene of the right kidney following torsion of the pedicle. The organ was removed in time to save the patient's life.

‡ This same displacement of the kidney, which occludes for a time the ureter, will also, by twisting the pedicle, affect its vessels. As Mr. Lucas points out, the vein will suffer more from pressure than the artery, thus causing turgescence of the organ generally as well as distension of its pelvis. Thus are brought about the nausea, pain, vomiting, &c., which have been described as strangulation or acute dislocation of the kidney. (Bruce Clarke, *Trans. Med.-Chir. Soc.*, vol. lxxvi. p. 263; *Brit. Med. Journ.*, vol. i. 1895, p. 575.)

show that the destruction of the kidney may occasionally go on without any severe attacks of pain. Mr. F. J. Steward (*Lancet*, vol. i. 1905, p. 1069) related two similar cases before the Clinical Society; the mobility of the kidney had caused kinking of the upper end of the ureter. In each case the kink was easily corrected by replacing the kidney. After nephrorraphy the average daily excretion of urea increased from 167 grains to 277 grains in one case. The other patient had had her hydronephrosis drained sixteen weeks before her admission into Guy's Hospital. The fixation of the kidney was successful in both cases.

5. Extreme mobility, not restrained by any apparatus that the patient can bear, and preventing the patient from taking proper exercise or following her occupation.

The following questions arise as to the sutures. (1) What is the best material? (2) What tissues are to be taken up?

The answer to each of these questions is, in my opinion, a simple one. (1) Kangaroo-tail tendon is an excellent material, but I prefer to use catgut suitably prepared to resist absorption for about six weeks. Silk, which is easily obtained and readily sterilised, with a little care will be quite efficient. It should not be of the plaited kind, it should be of medium size and carefully prepared. Buried as it is deeply, the use of silk here is less open to the objections to which I have alluded in the account of Radical Cure of Hernia.

(2) In answer to this question I am strongly of opinion that to ensure a permanent cure in nephrorraphy, the sutures should take hold of the proper capsule of the kidney itself, after this has been carefully peeled off in two flaps. I have tried other methods, *e.g.*, inserting them through the substance of the kidney itself, either fastening them to each side of the wound and dropping them in, or passing them from one lip of the wound through the kidney and finally through the other lip of the wound. The longer I watched my cases the less reason had I to be satisfied, though the earlier results had been excellent.

Methods of operating.—A great number and variety of operations have been invented and recommended for fixing a movable kidney. Many of them are not based on sound anatomical and mechanical principles, and others have been conceived in ignorance of Nature's ways of healing. No attempt will be made here to give an exhaustive account of all the ingenious devices that have been too often hastily recommended without allowing sufficient time to elapse for observation of the after results: only a few typical methods will be briefly described. Operations based on fixing the fatty capsule only have been proved to be unsatisfactory. There is little doubt from experimental and clinical results that firmer union occurs when the cortex of the kidney is bared, than when sutures which pierce the friable renal tissues are relied upon. Moreover such sutures are not quite devoid of danger, as already pointed out, and there are at least five cases on record in which these sutures have caused urinary fistulae due to laceration of the kidney. It is true that the leakage was not permanent, but it was troublesome and avoidable; in one case a second operation was required (Clayton Greene, *Lancet*, 1904, vol. ii. p. 1711). It is safer and better to pass the sutures through the capsule only, unless

the latter is too thin to be relied upon. In my opinion the usual oblique lumbar incision gives more room and far better access to the kidney and allows a more thorough examination of the pelvis and ureter than the vertical incision advocated by some surgeons, and my experience of the prone position has not impressed me favourably, for it certainly embarrasses the breathing, and increasing venous congestion and bleeding. All attempts to fix the kidney through the peritonæal cavity are to be condemned as futile and unnecessary. Passing stitches through the pleura and diaphragm to endeavour to fix the upper end of the kidney is not to be recommended, because it is at least meddlesome and it is enough to secure the lower two thirds of the organ. As regards the parietes, the kidney and its fibrous capsule should come into contact with the raw surfaces of the quadratus lumborum muscle and the deeper part of the parietal wound; but the kidney must not be drawn too much into the wound, where it will be exposed to injuries, and especially liable to nephritis, soon after the operation, as shown by Wolff (*Deutsche Zeitschrift für Chirurgie*, Leipzig, 1897, xlv. p. 533). Fixation of the lower end of the kidney only in the attempt to get it into a high position may lead to anteversion of the organ or to stretching of the adhesions, due to the pressure of the diaphragm and liver on the upper pole. On the other hand, fixation at too low a level may lead to kinking of the ureter and hydronephrosis, and perhaps to pain from the pressure of the corset at the waist.

For the average operator and an average patient it must be unwise to attempt to fix both kidneys at the same time, although Edebohl, with his great experience, has not found this heroic practice dangerous. In more than a third of his cases the double operation was performed.

To hope to get very firm adhesions from the granulation tissue formed as a result of gauze packing, scarification, or cauterising of the capsule with pure carbolic acid, is vain, for experience has proved that such adhesions are not, in the end, as strong as those obtained by primary union between raw surfaces kept in apposition by means of sutures. Carwardine (*Bristol Med.-Chir. Journ.*, March, 1905) however advocates the use of carbolic acid and gauze packing for this purpose. He quotes eight cases and states he has been able to prove that very firm adhesions follow his method. Rest in the recumbent position for at least three weeks is essential for the success of the operation.

Operation.—The kidney is first thoroughly exposed by the steps given at p. 172, an assistant keeping the organ well pushed up into the loin while the surgeon cuts down on it. I may here say that in some of these cases of very movable kidney the tissues around are so loose from the dragging and shifting to and fro of the kidney that they wrap round the organ very closely, and thus it is easy to injure the peritonæum. Thus, in one of the patients mentioned above the right kidney was mobile through an extremely wide range, and so loose that when lying on her left side the patient could make it project as a convex lump in the left iliac fossa. When I was operating on this side I found the kidney easily reached, but not easy to define, owing to the extreme looseness of the folds of the perinephritic tissue and

peritonæum.* This latter structure I opened in two places, the thin edge of the liver appearing at one, and some omentum in the other. The first opening was clamped and tied up with a catgut ligature, the second closed with a continuous suture of the same. Strict aseptic precautions were taken, and not the slightest ill result followed. This accident, which I have seen occur twice in one day, can be avoided by taking care to incise the fatty capsule at the upper and inner part of the wound.

The kidney itself having been exposed, it is gently withdrawn through the wound, and thoroughly examined for signs of disease, and the upper part of the ureter is also palpated for stone. Then an incision is made with a very light hand all along the convex border from end to end. Unless the utmost gentleness is taken in the last step the tissue of the organ itself will certainly be incised, causing free oozing. With the handle of a scalpel or a blunt dissector, flaps of capsule are then deliberately but gently stripped off the kidney up to a point about halfway along its lateral surfaces, so as to raise sufficient flaps for the sutures to find a holding in. The flaps having been raised they are sutured with medium-sized sterilised catgut to the aponeurotic and muscular edges of the wound. To get a firm and permanent holding, each suture should take up plenty of capsule on the one side and a sufficient grip of the lumbar fascia on the other. I generally use upwards of ten sutures, perhaps six in one flap and four in the other. One word of caution should be added. This method of anchoring is so efficient that, unless care is taken, it is possible to fix the kidney, which has been drawn out, actually between and not beneath the lips of the wound. After one row of sutures, say the upper, has been inserted, tied and cut short, and the second merely inserted, care should be taken gently to push the kidney into its proper place in the loin, just under the wound; the lower sutures are then also tied, cut short, and dropped in. Any oozing met with after stripping off the flaps of capsule will yield to firm sponge-pressure kept up by an assistant while the surgeon is putting in his sutures. It is well also to keep a sponge in the lower part of the wound, to be removed before the last sutures are tightened. If when all bleeding is arrested the wound is very carefully dried out, no drainage-tube will be required. In closing the wound I unite the edges of the muscles and fascia with buried sutures of chromic gut, and the skin with salmon gut. I recommend this method most strongly: it is both easy and efficient, and sufficient time has now elapsed in several of my cases for me to be able to say that no injury is inflicted on the kidney by the stripping off of its capsule. Newman ("Surgical Studies, Renal case") employs a very similar method and speaks well of the

* This was not a mesonephron, an exceedingly rare condition. I find that Dr. Drummond, of Newcastle, described a similar condition several years ago ("Clinical Aspects of Movable Kidney," *Lancet*, vol. i. 1890, p. 121): "In almost every instance in which the kidney has been found to be freely movable, the other abdominal organs have been correspondingly loose in their attachments—the spleen, liver, cæcum, stomach, &c. More than once a distinct mesonephron was present, but much more often the peritonæal covering was simply loose, so that the organ could be easily placed in various novel positions. At times the kidney had dragged the relaxed peritonæum so far from the abdominal wall as to bring into close conjunction the upper and lower layers, so as to form a false mesonephron."

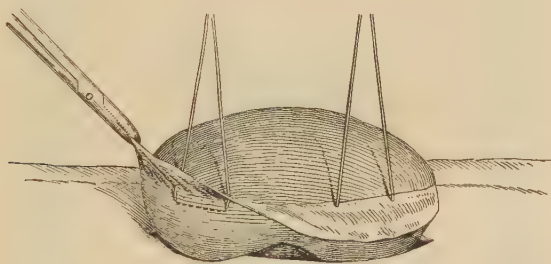
results. He inserts a large drainage-tube between the kidney and the deeper parts of the wound in order to promote adhesions to the wound.

Arbuthnot Lane (*Clin. Soc. Trans.*, vol. xxv. p. 203) raises about ten triangular flaps of the capsule of the posterior surface of the kidney; each flap is twisted and tied with silk brought through the muscles and fixed by tying the adjoining ligatures.

Blair (*Interstate Med. Journ.*, May 4, 1904) makes use of a very similar plan, but he only raises three flaps, two of which have their bases at the outer border and the other remains attached at the pelvic border. These are drawn untwisted through the fatty capsule, the lumbar fascia and the muscles of the back, and fastened with catgut sutures. "The peritonæum around the kidney is also sutured to the lumbar fascia so as to draw it taut over the anterior surface of the organ, as an additional support.

Edebohls' Operation (*Ann. of Surg.*, 1902, vol. xxxv. p. 174).—The patient is placed in the prone position with an air cushion (fourteen

FIG. 64.



Nephropexy (After Edebohls; *Ann. of Surg.*). The suspension sutures placed in the fibrous capsule.

inches long and eight inches in diameter) supporting the abdomen and pushing the kidneys well back into the loin. Edebohls maintains that this position does not embarrass the breathing or render anæsthesia difficult or dangerous; it greatly facilitates the finding and delivery of the kidney.

A vertical incision is made along the outer border of the erector spinæ from the last rib to the iliac crest; the fibres of the latissimus dorsi are separated, and the lumbar fascia is incised so as to expose the perirenal fat, and sometimes the ileo hypogastric nerve which may be drawn aside or divided and reunited later on.

The anterior lamella of the lumbar fascia is slit vertically and retracted in order to expose freely the muscular fibres of the quadratus lumborum, which are destined to form an adhesive bed for the kidney.

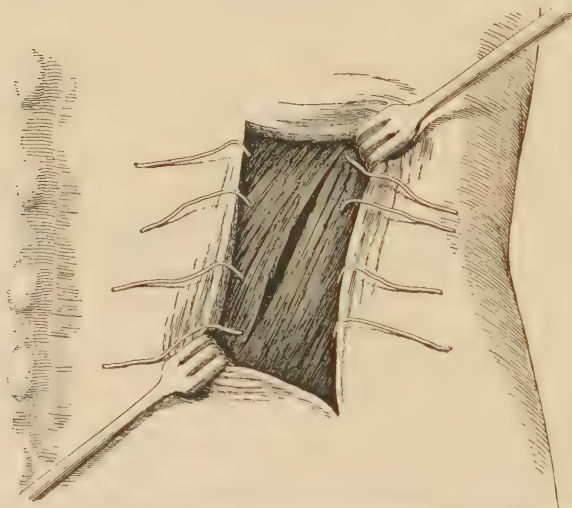
The kidney is sought and freed by the fingers, and together with its fatty capsule it is brought out on to the loin; if the incision is too small to allow this, more room may be obtained by incising the outer fibres of the quadratus near the ilium. The fatty capsule is removed, and the kidney, pelvis, and upper part of the ureter are thoroughly palpated and inspected, or even incised if necessary. The fibrous capsule is nicked at the middle of the convex border and slit from pole to pole along a grooved director. Anterior and posterior flaps are raised by

blunt-dissectors, so as to denude the outer half of the cortex ; some of the flaps may be removed if they are too large.

"Four suspension or fixation sutures of forty-day catgut" are passed through the fibrous capsule, two to each flap, as shown in Fig. 64. Each suture pierces the flap near its base and also the attached capsule under which it runs for a distance of two to three centimetres ; a Hagedorn needle held on the flat is used to pass the suture to avoid penetration of the cortex of the kidney.

When all the sutures have been placed, the kidney is returned into position, and the anterior and posterior sets of stitches are passed through the parietes at a distance of about $1\frac{1}{2}$ inches from each other. The inner sutures pierce the anterior lamella of the lumbar fascia, the quadratus lumborum, the erector spinæ and the latissimus dorsi, the outer ones pass through the lumbar fascia and the latissimus dorsi.

FIG. 65.



Nephropexy (Edebohls). The suspension sutures piercing the muscles ; the fibres of the latissimus dorsi have been separated only.

The highest stitches are close to the last rib. The parietal wound is closed with catgut sutures "passed in such a manner as to turn the raw surface of the quadratus towards the kidney," and lastly the suspension sutures are tied as shown in Figs. 65 and 66. The wound is not drained, but is completely closed by means of the intra-cuticular suture.

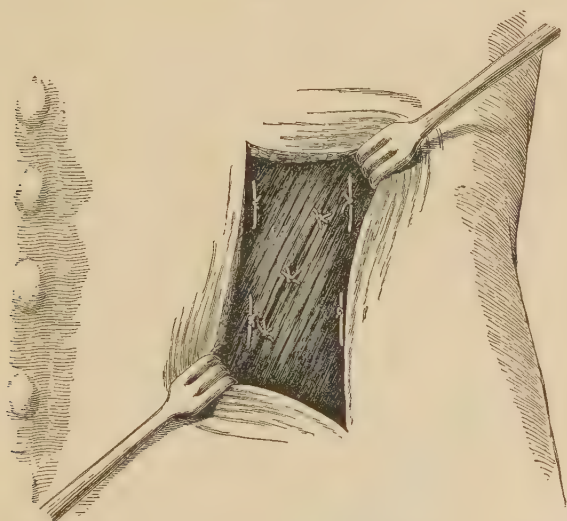
Edebohls does not claim that the kidney is fixed as high as the normal position, but that it is placed high enough for practical purposes. Moreover, he maintains that it is not wise to attempt high fixation, lest the liver in descending lengthen the adhesions, or cause anteversion of a kidney which has only been fixed at its lower part, which is common when high fixation is attempted.

So certain is he that other diseases frequently co-exist with movable kidney, that he often opens the peritonæum to the outer side of the kidney, and explores the gall bladder and ducts, the duodenum and pylorus, and especially the appendix, which he often removes through the loin. He then closes the peritonæum and proceeds with the nephropexy.

Tuffier's Method (*Traité de Chirurgie*, Duplay and Reclus, 2nd ed. 1899, tome vii.).—The kidney is approached through a slightly oblique or nearly vertical incision extending from the eleventh rib to the crest of the ilium. The fatty capsule is separated from the fibrous one on both surfaces and the outer border.

Two thick sutures of catgut or kangaroo-tendon are passed through the kidney, one near the lower pole and the other about 4 centimetres below the upper end. A third suture is passed between these two when the cortex has been exposed on the posterior surface and outer border by dissecting off the fibrous capsule. The stitches are fixed to the parietes, the upper one to the periosteum on the back of the twelfth rib and the others to transversalis fascia. Care is taken not to tie them so tightly as to lacerate the kidney, which they serve to anchor

FIG. 66.



Nephropexy (Edebohls). The four suspension sutures tied, and the wound closed by separate suture.

to the lumbar wall lower than the normal position. The wound is closed in layers by buried catgut sutures, no drainage being used.

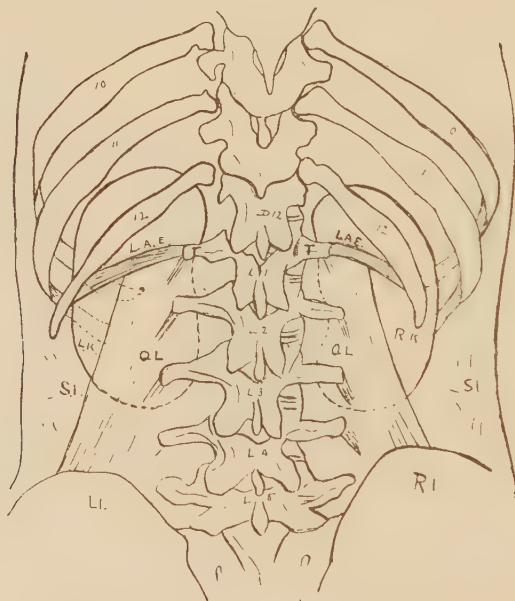
Jonnesco's Method (*Centralblatt für Chirurgie*, No. 30, 1897).—Jonnesco, having tried the vertical incision, preferred and adopted the oblique one, as it enabled him to fix the kidney to the ribs. He detaches the true capsule along the whole length of the convex border, three silk or silver wire sutures are passed through the skin 3 cm. to the inner side of the wound, through the erector spinæ and the lumbar fascia, the capsule, the posterior surfaces of the kidney $1\frac{1}{2}$ cm. from the outer border, through the capsule again and the periosteum of the twelfth or eleventh rib, and all the soft parts to the outer side of the wound. Two sutures are passed near the poles and the other at the middle of the kidney; they are tied so as to suspend but not to lacerate the organ. The stitches are removed after ten days. Jonnesco claims that his method is simple and efficient, that the sutures do not tear out because they pass through the capsule of the kidney, and that

being removed after ten days, they do not cause unpleasant after-effects like pain, suppuration, fistula, or fibrosis of the kidney substance.

In this operation the kidney is fixed with its axis turned out of the normal and parallel to the last rib.

Fullerton's Operation (*Brit. Med. Journ.*, Dec. 24, 1904).—The kidney is approached through the usual oblique incision, and "it is pushed up to but not out of the wound." A large flap of the true capsule is then raised from the posterior surface and outer border of the kidney, the base of the flap being "just above the centre of the horizontal axis of the kidney." The inner border of the flap is made longer than the outer, to preserve the inward tilt of the upper end of

FIG. 67.



The kidney from behind (Fullerton). The ligamentum arcuatatum externum, L.A.E., is shown. Q.L.—Quadratus Lumborum.

the organ. The finger is now insinuated deep to the ligamentum arcuatatum externum, which is easily found stretching horizontally from the lower border of the last rib near its tip to the transverse process of the first lumbar vertebra in front of the quadratus lumborum. The tissues on the anterior surface of the ligament are pushed up "so as to get rid of the pleura should it descend lower than usual. While the finger thus protects the pleura, an incision is made about a third of an inch or more above the lower margin of the ligament, and parallel to its fibres for the whole available distance between the quadratus lumborum and the tip of the last rib."

By means of forceps the flap of capsule is drawn backwards through the slit in the ligament, spread out and sewn "to the ligament and neighbouring parts with catgut or silk." "Other stitches may be used to unite the capsule at the margins of the raw surface to the

lumbar fascia at the sides and below if considered necessary" (vide Figs. 67 and 68).

Mr. Fullerton does not claim that the kidney is replaced in its normal position, but believes that "it is fixed a little lower than normal, but it is slung by its own capsule, and for all practical purposes it is in excellent position."

At the time of writing his paper Mr. Fullerton had performed the operation three times on the living subject. The following criticisms may be made. No mention is made of the removal of any of the perirenal fat, and as the kidney is not brought out of the wound, a co-existing lesion of the kidney may easily be overlooked.

In answer to my enquiries, Mr. Fullerton kindly wrote in October, 1906, that he has seen some of the cases nearly two years after operation, and that the kidneys remain fixed. His senior colleague, Mr. Mitchell, has adopted the operation in preference to all others.

Morris' Operation (*Surg. Diseases of the Kidney and Ureter*, 1901, vol. ii. p. 231).—Morris exposes the kidney through his usual oblique lumbar incision, and removes a considerable part of the perirenal fat, but he does not believe it to be necessary to interfere with the fibrous capsule in any way. He passes three silk sutures "into the posterior

FIG. 68.

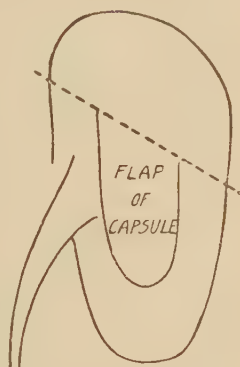
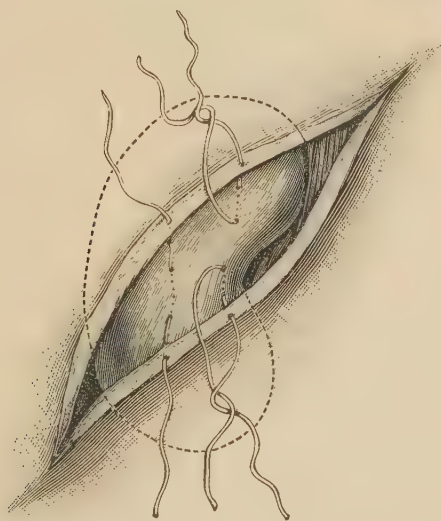


Diagram of right kidney and flap (Fullerton).

FIG. 69.



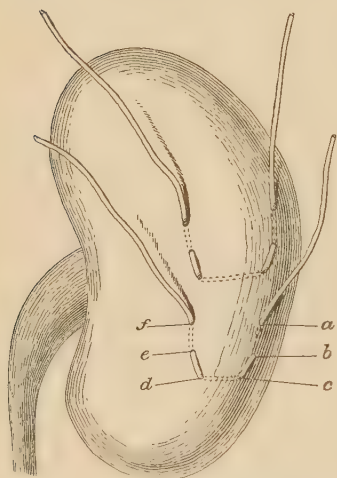
Nephropexy (Morris' Operation). Left kidney shown. The sutures are represented in the figure too near the hilum (Morris).

surface of the kidney, one nearer the upper, the other nearer the lower end, and the third midway between the other two, but nearer the hilum. Each suture is buried for a length of three-quarters of an inch within

the renal substance, and penetrates about half an inch into the thickness of the organ." The sutures are then passed through the edges of "the shortened adipose capsule, the transversalis fascia, and the deeper layers of muscles, and tied to them as shown in figure 69.

Only one of the sutures serves to narrow the parietal wound, which is closed by silk sutures passing through all the layers including the skin. A drainage tube is often used. The wound usually heals in a week, but the patient is kept in bed for from four to five weeks. Mr. Morris sometimes uses Vulliet's method in severe cases in young women and speaks highly of it; he also raises capsular flaps from

FIG. 70.



Nephropexy (After Goelet; *Ann. of Surg.*). The suspension sutures placed in the true capsule. (Posterior view.)

edges of the renal wound when an exploration of the kidney has been considered necessary.

He considers that M'Ardle has exaggerated the risk of sepsis and phlebitis involved by sutures penetrating the renal tissues, and also that the danger of including one of the large renal arteries (Barth) is avoided by passing the sutures only from the posterior surface and not through the thickness of the organ. Morris has operated on more than eighty cases without a death.

Goelet's Operation (*Ann. of Surg.*, 1903, vol. xxxviii. p. 769).—The kidney is exposed as in Edebohls' operation (p. 227), and the fatty capsule is dragged downwards and opened at the upper and inner angle of the wound to avoid opening the peritonæum or injuring the colon. Traction is made on the fatty capsule, and the kidney is delivered into the wound. The fatty capsule is com-

pletely separated from the kidney, and thus the duodenum and colon are detached from the anterior surface. The pelvis and ureter are searched for stone.

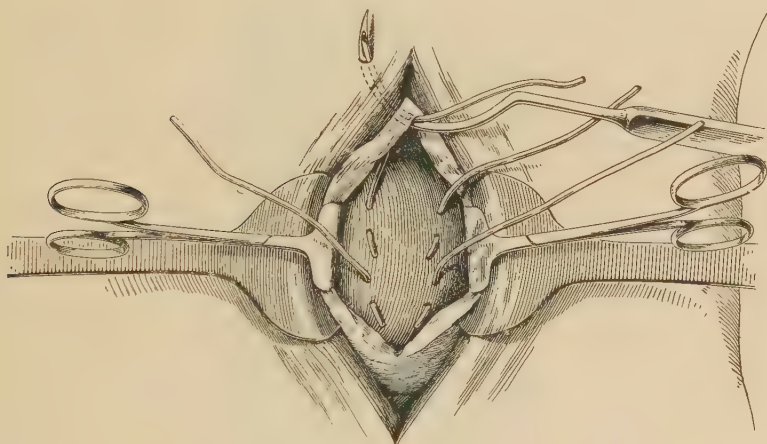
The capsule is neither detached nor split, as Goelet believes this to be unnecessary for firm union granting that non-absorbable ligatures, which do not stretch, are used, and that these are tied so that they cannot become loose by cutting into the tissues. Goelet uses silk-worm gut made pliable by boiling and preserving in 3 per cent. Lysol.

Two sutures are inserted into the posterior aspect of the free border kidney, one at the junction of the middle and lower third, and the other about the centre of the kidney (*vide* Fig. 70). "A small fully curved needle one inch long is used to pass the sutures.—The lower one pierces the true capsule at *a* and passes beneath it for half an inch to *b* superficially to it for nearly half an inch to *c*, deep to it for half an inch from *c* to *d*, and superficially from *d* to *e*, deeply from *e* to *f*. Goelet maintains that the strain upon the sutures "is in a direction parallel to the surface of the kidney and its capsule, and not at right

angle to it," as in all other forms of suture used; therefore it requires great tension to make the stitch tear out.

All redundant fatty capsule is torn off or excised with scissors, due care being taken not to injure the bowel or open the peritonæum. The kidney is then replaced, and the sutures are then passed through all the parietes near the upper end of the wound, by means of a long curved perinæal needle (*vide* Fig. 71). They are tied over a roll of gauze placed longitudinally. This forms a cushion for the suture loop to rest upon, and prevents the sutures from cutting through the skin and consequent loosening of the loop. A gauze drain is packed around and below the lower pole of the kidney to keep back the fat which has not been removed. The wound is sewn up in layers, except at the lower angle where the gauze packing protrudes. The sustaining

FIG. 71.



Nephropexy (After Goelet; *Ann. of Surg.*). The suspension sutures being passed through the whole thickness of the parietes.

sutures are not removed until the twentieth day, and the patient is allowed to get up next day.

Goelet lays great stress on the importance of complete removal of the fatty capsule, and especially upon the detachment of the duodenum and colon to prevent these from dragging on the kidney. He also seems to think that he can prevent these structures from re-adhering to the kidney by means of gauze packing, and early stimulation of intestinal movements. He claims that he has had no recurrence in 171 operations on 134 patients, 37 of these having both kidneys fixed on the same day.

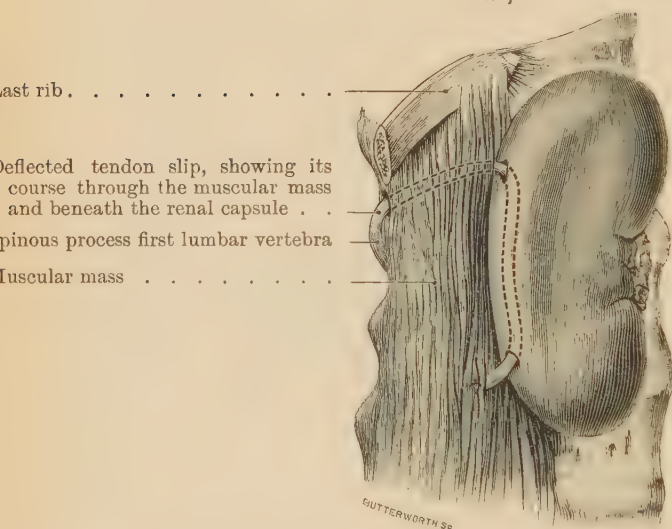
It may be objected that these cases had not been observed long enough for the conclusions to be final, for the first of the operations was only performed about three years before Dr. Goelet's paper was read.

The Method of Vulliet (*Revue Médicale de la Suisse Romande*, 20 Juin, 1895, p. 326).—The kidney having been exposed and freed in the usual way, another short vertical incision is made close to the

spinous process of the last lumbar vertebra, and a tape-like slip of the tendon of the erector spinæ is pulled out but left attached at its lower end. Thomas (*Brit. Med. Journ.*, Nov. 8, 1902) uses a swivel to aid him in detaching a suitable length. The slip should be about ten inches long and a quarter of an inch wide. It is passed by means of a long straight blunt needle in a handle and with a large eye near the extremity, through the muscular tissues of the erector spinæ and quadratus lumborum. "It is made to underrun the fibrous capsules of the kidney upon its posterior surface and near the external border, it is then passed back again and fixed to the erector spinæ muscle by means of a suture of fine silk" (Morris, *vide* Fig. 72).

Morris sometimes modifies this operation when too short a length

FIG. 72.



Vulliet's method of fixing the kidney. A side view, showing the spinous processes, as well as the side of the bodies of those bones. The kidney is *in situ*, but the suture is made to appear to enter on the anterior instead of the posterior face. Diagrammatic, copied from Vulliet's paper (Morris).

of tendon tears out by splitting the latter and passing the two through the muscles to the kidney, and one of them under the capsule. The two strands are then tied firmly together. Morris recommends Vulliet's operation, but states that patients complain of pain in the back for a short time. Thomas (*loc. cit.*) reports 10 successful cases.

The Mortality of Nephropexy.—Morris reports 80 operations without a death, and Tuffier 75 with 2 deaths. The latter has also collected 173 records with a mortality of 4.4 per cent. for all operators (Morris, *loc. cit.*, vol. ii. p. 236).

Edebohls collected records of 836 operations by surgeons with experience of at least 15 operations each; the mortality was 1.65 per cent. Edebohls himself (*loc. cit.*) reports 193 operations with 3 deaths, a mortality of 1.55 per cent. More than a third of these patients had bilateral operations, and in 52 the appendix was also

removed. In 2 nephrectomy was performed on the opposite side at the same operation (a most hazardous proceeding).

Goelet records 171 operations on 134 patients without a death (*loc. cit.*).

Edebohls has also operated on 135 successive cases without a death, and he quotes Johnston as having operated 107 times without a fatality. It may be stated that at the present time the mortality should not be more than 1 to 2 per cent. for skilful and aseptic surgeons.

Death may occur from sepsis, peritonitis, tetanus, pulmonary embolism, broncho-pneumonia, uncontrollable vomiting. Pulmonary embolism is a common cause of death and is probably due to thrombosis of the renal vein, which may occur when the kidney has not been pierced by any suture; it may be due to laceration of the lining of the vein during forcible attempts to deliver the kidney combined with the enforced rest that must follow the operation. As far as I know, the clot has not been proved to be septic in origin.

Accidents that may happen during the operation. Laceration of the kidney may occur during its delivery, but it is more common as the result of tension on sutures which pierce the kidney. Edebohls (*Ann. of Surg.*, 1902, vol. xxxv. p. 157) reports a case in which a fistula persisted for three and a half months, and he refers to three other cases.

Clayton Greene (*Lancet*, 1904, vol. ii. p. 1711) has reported an interesting case, which is probably unique. A fistula followed the use of deeply penetrating catgut sutures. It closed after the removal of some deep sutures, but six months later another operation was required for pain and swelling. A clear fluid, presumed to be urine, was found within a greatly thickened true capsule, which was detached from the kidney, except at the hilum. Mr. Clayton Greene calls this condition external hydronephrosis.

The peritonæum may be opened, because the liver may be mistaken for the kidney. The colon may be wounded, and the pleura has been opened causing temporary pneumothorax. The ureter has been torn.

Complications.—Septic infection, nephritis, neuralgia from section or involvement of nerves in the scar.

Hernia may occur, but Edebohls was only able to discover records of nine cases.

Results.—It is to be regretted that some of the energy devoted to inventing and publishing new methods is not spent on following cases and recording ultimate results.

Very few statistics are of any great value, because the patients have not been examined after a sufficient length of time; it is absurd to claim cures after a few months only, for it is well known that fibrous adhesions often stretch, and even vanish in time. The scar that follows free drainage for suppurative peritonitis seems firm enough for some months, but a ventral hernia appears as a rule sooner or later.

Goelet (*loc. supra cit.*) claims that he has only had one partial failure after 171 operations, but his cases could not have been observed long enough to justify this optimism, for the first of the operations was performed only three years before the results were published.

Edebohls (*loc. supra cit.*) maintains that not a single one of the kidneys which he has anchored has, to his personal knowledge, again

become movable. Everyone knows, however, that it is practically impossible to trace all cases, especially failures, which often go elsewhere. The following figures are of more value, being more definite: In 1898, Edebohls personally examined 55 of his patients which had been operated upon from one to eight years previously. In 50 the kidney was firmly fixed; in five the adhesions had stretched more or less, but none of the kidneys could be pushed up under cover of the ribs, as in an ordinary movable kidney. Edebohls therefore asserts that they are not detached. One seemed to be movable enough to require a second operation, which showed that the kidney was fixed, and could not be detached without tearing the renal tissues. Keen, quoted by Treves, gives the results of 116 operations. After three months only 57·8 per cent. were regarded as cured, and 12·9 per cent. improved, and 19·8 per cent. were considered to be failures.

McWilliams (*Med. News*, Oct. 4, 1902) records 61 cases, of which 42 were traced; 22, or 52 per cent. were considered to be cured, and 15, or 35·7 per cent. benefited, and 5 cases, or 10 per cent. not benefited. Of 19 simple cases, 12, or 63 per cent. were cured. Out of 23 complicated cases, 10, or 43 per cent. were cured; 2 of the 61 died, giving a mortality of 3·2 per cent.

The results must be judged by a more important test than that of mobility; it is far more essential to know if the patient has or has not obtained relief from her symptoms. The relief of symptoms will generally prove both the accuracy of the diagnosis and the efficiency of the treatment. It is poor consolation to know that a kidney has been fixed when symptoms supposed to have been due to its mobility still persist. On the other hand, it matters little if a kidney become slightly too movable if the patient does not suffer *from it*. It is to be hoped that more prominence may be given to these points in future statistics.

THE SURGICAL TREATMENT OF BRIGHT'S DISEASE.

Mr. Reginald Harrison (*Brit. Med. Journ.*, 1896, vol. ii. p. 1125) was the first to advocate surgical treatment for nephritis; he suggested that the improvement which may follow chance operations upon kidneys which are in a state of chronic nephritis might be due to the relief of tension within the capsule of the kidney. Harrison therefore practised and recommended renipuncture for Bright's disease, later he performed capsulotomy and nephrotomy.

Israel in 1899 drew attention to the disappearance of symptoms of renal disease after negative explorations for stone, but he did not recommend surgical interference for Bright's disease (*La Sem. Med.*, Feb. 5, 1904). Ferguson, Edebohls, and Pousson, in 1899, advocated surgical intervention in certain cases of nephritis, including chronic Bright's disease.

In view of the grave prognosis of this disease under medical treatment, it is certainly worth while to consider the advisability or otherwise of seeking aid from surgery, but it remains to be proved that operations are either hopeful or even justifiable in any cases of genuine Bright's disease (*vide* p. 162).

Two operations require consideration.—I. Harrison's operation (*Lancet*, 1901, vol. ii. p. 330). The patient having been anæsthetised,

the kidney is exposed through the usual oblique lumbar incision (*vide* p. 172); the fatty capsule is opened, and an assistant pushes the kidney towards the operator. It is not necessary to deliver the organ on to the loin unless the diagnosis is uncertain, and a thorough examination is indicated on that account.

The fibrous capsule is exposed and incised along the convex border for a distance of about 2 or 3 inches. In some cases Harrison punctures the kidney in various directions, avoiding the pelvis; in others he incises the cortex more or less freely.

The wound is only partly closed, a drainage tube being inserted and left in position for a week or ten days. Drainage is considered to be an essential part of the treatment. In a case of nephritis it does not matter which kidney is selected for the operation, unless pain is present on one side.

"Both organs are usually involved in the inflammatory condition, though perhaps it may turn out not to the same degree. In double nephritis, the relief of tension in the one organ aids the other, and thus, as I have noticed on several occasions, the normal amount and constitution of the urine becomes re-established."

The Indications for the operation as given by Mr. Harrison, at the International Congress at Lisbon, 1906 (*Lancet*, 1906, vol. i. p. 1202) are as follows:—

"(1) Progressive signs of kidney deterioration as shown by the persistence or increase of albumen when it should be disappearing from the urine, as in the natural course of inflammatory disorders ending in resolution.

(2) Actual or threatened suppression of urine.

(3) Where marked disturbance of the heart and circulatory system occurs in the course of inflammatory renal disorders."

A consideration of the pathology of Bright's disease, of the experimental evidence (*vide* p. 239), and of the theory of renal tension, does not commend this operation to me; it is almost certain that any relief that may be derived from an operation may be obtained with far less risk by medical treatment.

The following remarks made by Mr. Henry Morris, after a vast experience of diseases of the kidney, show how dangerous operations may be in Bright's disease:—"Surgical operations and more especially operations upon the urinary organs, if it be possible to postpone them, should never be undertaken during the existence of acute or sub-acute interstitial nephritis, or any form of 'congestive' urinary fever" (*Surgical Diseases of the Kidney and Ureter*, vol. i. p. 316). When a series of consecutive cases treated by operation is published and the results are found to compare favourably with those obtained by less heroic measures, physicians may no longer shrink from submitting their patients to operation, but until then discretion is certainly the best part of valour.

2. Renal Decapsulation.—Edebohl's "originally devised, proposed and performed" this operation for the treatment of chronic Bright's disease (*Med. Rec.*, Dec. 21, 1901, pp. 961-970, and *Med. News*, April 22, 1899). He exposes the kidney through the vertical incision, which has already been described under nephropexy at p. 227, and the patient is placed in the prone position with an air cushion supporting the abdomen.

Both kidneys are therefore accessible without changing the patient's position. The following description is taken from Dr. Edebohls paper in the *Brit. Med. Journ.*, 1902, vol. ii. p. 1507: "If possible, next deliver the kidney into the wound or out upon the skin of the back, a procedure which greatly facilitates further operative procedures in both renal decapsulation and nephrotomy. When such delivery of the kidney is impossible, the rest of the work must be done at a great disadvantage with the kidney well up underneath the lower ribs and with the fatty capsule constantly overlapping the organ to a greater or less extent." By adopting the usual oblique incision it is much easier to bring the kidney into the wound, especially in men and in patients with a small interval between the last rib and the iliac crest, and the risk of hernia is very small if the muscles are sutured carefully.

"In performing renal decapsulation the operator next proceeds to bluntly separate the fatty capsule from the capsule proper, the dissection being continued on either aspect and around both poles of the kidney until the renal pelvis is reached. Now and then the fatty capsule may be found so thickened and adherent, as the result of chronic perinephritis, that the scissors or knife may be required to separate it from the capsule proper. The kidney with its capsule proper is next lifted from its fatty capsule bed, and if possible delivered into or through the wound. The capsule proper is divided on a director along the entire length of the convex external border of the kidney and clear around the extremity of either pole. Each half of the capsule proper is in turn stripped from the kidney and reflected toward the pelvis until the entire surface of the kidney lies raw and denuded before the operator. In separating the capsule proper from the kidney care must be taken not to break or tear away parts of the kidney substance, which is often very friable and very firmly connected with the capsule proper, especially in the presence of chronic interstitial nephritis. I have found the smooth surface of the index finger of the rubber gloved hand the best instrument for safely effecting separation of the capsule proper from the kidney. The stripped-off capsule is next cut away entirely, close to its junction with the pelvis of the kidney, and removed. Delivery of the kidney into the bottom of or out of the wound greatly facilitates the decapsulation part of the operation, whereas if the kidney cannot be readily reached, the operation sometimes becomes very difficult. In the latter event the entire kidney capsule proper may have to be peeled off at a finger's length on the bottom of the wound beyond the reach of sight." All the capsule should be excised if possible, but if this is not practicable the small remainder should be separated and everted towards the root of the kidney.

The kidney is dropped back and the wound closed without drainage except under exceptional circumstances. Both kidneys are operated upon at one sitting so as to avoid the dangers of two anæsthetics, which is important in these cases of nephritis. "Decapsulation of both kidneys for chronic Bright's disease requires for its performance from half an hour to one hour from the first incision to complete closure of both wounds and the application of dressings." . . . "Decapsulation of one kidney is, in itself, less serious than either nephropexy, nephrotomy, resection of the kidney or nephrectomy."

Edebohls has performed his operation not only for cases of Bright's disease, but also for acute pyelo-nephritis with miliary abscesses, hydronephrosis, pyonephrosis, polycystic kidney, and puerperal eclampsia.*

It is probable, as he admits, that the cases of ascending suppurative nephritis would have recovered without operation. In two cases decapsulation was only used in addition to nephropexy, for mobility, and the benefit undoubtedly derived from the combined operation was almost certainly due to the fixation, which may perhaps have been made more secure by the removal of the capsule (*Brit. Med. Journ.*, 1902, vol. ii. p. 1507).

From observations which were made during three secondary explorations upon kidneys, which had previously been fixed, Edebohls concludes that decapsulation allows anastomoses to occur between the vessels of the perinephritic tissues and those of the kidney, and that this may provide an additional blood supply to the organ. An increase of blood supply may lead to absorption of the inflammatory products, and to the removal of pressure upon the tubules and glomeruli, which may then resume their normal function. It is not claimed that improvement is rapid, but that it is progressive, the albumen only disappearing after from one to twelve months.

Edebohls (*New York Med. Journ.*, May 21, 1904) states that decapsulation for chronic Bright's disease has been performed in 200 to 300 cases. He recommends the operation for every case of chronic Bright's disease which has a reasonable expectation of life of not less than one month without an operation, if no contra-indication to any operation is present and if the services of a surgeon of experience can be obtained. He does not regard cardiac complications as contra-indications unless the heart is dilated and weak, but albuminuric retinitis is considered to be an absolute objection, for of all the nine patients having this complication, not one survived the operation for a year.

Edebohls had operated upon 72 patients up to the end of 1903. Of these 47 survived and had been traced for periods varying from 6 months to 12 years, 19 of them suffered from chronic diffuse nephritis, 17 from chronic interstitial nephritis, 7 from chronic parenchymatous nephritis, and 4 had chronic interstitial nephritis of one kidney and chronic diffuse inflammation of the other. 21 of the patients were cured, and only 6 were not improved to some extent, the greatest improvement occurring in the cases of chronic interstitial nephritis, and the least in the chronic diffuse nephritis.

Edebohls states that strict asepsis is essential for success as the subjects of nephritis do badly if their wounds suppurate.

Walker Hall and G. Herxheimer (*Brit. Med. Journ.*, April 9, 1904) found that a new capsule thicker than the old one forms within about three weeks in rabbits. Johnson was unable to find any anastomoses between the renal and perirenal vessels in dogs, and Tuffier (*Presse Méd.*, April, 1905) arrives at the same conclusion, after failing to induce any anastomosis by tying the renal vein and constricting the renal artery of the decapsulated kidney.

Claude, Balthazard, Jaboulay, and Gifford (*Med. Rec.*, July, 1904) did not find any marked anastomoses between the decorticated kidney and the adherent tissues of rabbits; acute nephritis, induced by injection of neutral ammonium chromate, was not influenced by decortication undertaken three days later (Hall and Herxheimer). Decapsulation has been even shown to induce interstitial nephritis in some rabbits. If decapsulation does any good, it probably acts by relieving tension and congestion.

* Two successful cases (*Boston Med. and Surg. Journ.*, June 2, 1904).

Hubbard (*Boston Med. and Surg. Journ.*, Jan. 28, 1904) reports 7 cases of decapsulation of the kidney, but albuminuria did not cease in any of the patients, and 5 of them died within 6 months of the operation, 2 within 19 days. Freeman (*Ann. of Surg.*, vol. xxxix., 1904, p. 370) records a case of unilateral hæmaturia for which decapsulation was performed; the surface of the kidney "was granular and mottled yellowish grey, and the fibrous capsule adherent." A small piece was removed and examined; the glomeruli and interstitial tissues were inflamed. No return of hæmaturia occurred during the 7 months of observation before publication. A cure should not be claimed in this short time, for the man had suffered from attacks of hæmaturia on and off for twenty years.

Baker (*Zent. f. Chir.*, 1904, No. 14) has endeavoured to improve the operation by bringing a piece of omentum backwards through a peritonæal perforation and wrapping it round the kidney. As the omentum is far more vascular than the perirenal fat, a freer anastomosis is expected to form. Tuffier (*loc. sup. cit.*) found even this to be of no avail.

Berg (*Med. Rec.*, June 18, 1904) advises decapsulation in cases of nephritis which have reached a stationary stage, and in which medical treatment is of no more avail. He believes that nephritis due to sclerosis of the vessels or to chronic suppuration is not benefited by the operation.

Ramon Guiteras (*New York Med. Journ.*, Nov. 7, 1903) found that the leading American surgeons are about equally divided for and against the operation of decapsulation for chronic nephritis. Of 120 cases which he collected 16 per cent. were cured, 40 per cent. improved, 11 per cent. unimproved and 33 per cent. died. The mortality in chronic interstitial nephritis was 26 per cent. and that of chronic diffuse nephritis 75 per cent.

H. J. Whitacre (*Journ. Amer. Med. Assoc.*, May 23, 1903) records a case of suppression of urine which had lasted for eight days, and was then relieved by decapsulation of both kidneys, but suppression is occasionally relieved without any operation.

Whether decapsulation will ever become a recognised method of treatment of intractable cases of chronic Bright's disease is uncertain. So far it has not found favour with English surgeons and physicians.

Theoretically there is little to recommend it, for a free vascular anastomosis can hardly be expected to form between the kidney and the anæmic fatty capsule which surrounds it. The tension within the fibrous capsule cannot be high for any length of time, for the capsule is thin and delicate in cases of chronic nephritis, and it is quite capable of stretching, as is shown by the rapid enlargement of the kidney, which occurs in acute nephritis, and in some cases of hydro-nephrosis. Moreover, the kidneys of chronic interstitial nephritis are usually smaller than normal, and still it is in these cases that decapsulation is claimed to do most good. It would be far more reasonable to take away or incise the dense and thick tunica albuginea from an inflamed testicle for the relief of tension, than it is to remove the thin capsule which invests a shrunken and chronically inflamed kidney. In acute nephritis, incision of the capsule might really be expected to relieve tension, but decapsulation has not been at all successful in these cases, although a few recoveries have followed operation for actual or threatened suppression of urine in scarlatinal nephritis. These results were not necessarily due to the interference, but may have occurred in spite of it.

Is it to be expected that decapsulation may arrest a renal degeneration and vascular sclerosis, that have gradually increased for years, in the majority of the subjects of chronic Bright's disease?

Experimental evidence lends but little if any support to the advocates of this operation, and it fails to demonstrate any real anatomical reason for its supposed success. The literature of the subject is full of vagueness, inaccuracy and confusion. Cases of movable kidney, with or

without nephrectasis, have been frequently classified as instances of Bright's disease, and even cases of ascending nephritis have been included. No one denies that decapsulation and fixation of a movable kidney may do good, and that the hydro-nephrosis and transient albuminuria which may be secondary to it may be cured by nephropexy.

Newman drew attention to this fact ten years ago (*Lancet*, January, 1886, p. 166). These cases should not be confused and classed with those of the bilateral and far more serious disease which was described by Bright.

Many writers seem to forget that patients not uncommonly recover from Bright's disease without operation, and particularly that spontaneous improvement may occur and last for a long time, only to be followed by relapse after months or years. Recorded cases, with few exceptions, have not been followed up for a sufficient length of time to justify their classification as cures. It may be seriously doubted whether the results in patients who survive the operation are any better than those obtained in the same time and with far less risk by medical treatment. Suppuration is apt to occur in the wound even when every care is taken to avoid sepsis, and Edebohls lays stress on the dangers of the anæsthetic in these patients.

The operation is very dangerous in acute nephritis, and it should not be undertaken in patients with cardiac dilatation and anasarca. Albuminuric retinitis is an absolute contra-indication.

It may be stated in conclusion that published facts do not lead us to hope for favourable results from surgical interference in Bright's disease. In suppression and perhaps in grave cases of eclampsia, an operation may not be more dangerous than leaving well alone, and time and experience may prove that incision of the renal capsule may give relief. In some cases of chronic interstitial and chronic parenchymatous nephritis, which have been medically treated without avail, the patients should be given the opportunity of declining or accepting an operation which may offer a faint hope of relief; but all the dangers and chances of the operation should be explained to the patients and their relations. Decapsulation of both kidneys offers the best prospect, but this should not be undertaken except by a skilful and aseptic surgeon, and under the most favourable circumstances.

OPERATIONS ON THE URETER.

There are two main conditions in which operations on the ureter are necessary :

A. Ureteral Obstruction.

B. Injuries to the Ureter.

A. Ureteral Obstruction.—This in the great majority of cases is due to the impaction of a calculus in the ureter; in others, however, it has been found to be due to a valvular formation at the opening of the ureter into the renal pelvis or to a stricture of the ureter. These conditions will be considered separately.

I. URETERAL CALCULUS.—There can be no doubt whatever that in many cases, where a renal calculus has been diagnosed and no calculus found, the stone has really been in the ureter.

Morris (*Surgical Diseases of the Kidney and Ureter*, vol. ii. p. 448) during his first twenty years' experience of renal surgery "had six cases in which a stone must have been present in the ureter at the time of the operation, although the kidney was explored with a negative result in each case." Five of these patients subsequently passed a calculus, and the other one died about a year later, and a stone was found near the lower end of the ureter. Other surgeons have had the same experience, but in many cases the stone has been fortunately found in the ureter near the kidney. At the present day there is less excuse for this error, which was unavoidable in the past, for the introduction and the perfection of systematic examination of all the urinary organs by means of the X-ray screen has provided the surgeon with a means of almost accurately localising calculi before any operation is undertaken for their discovery and removal.

Whenever possible such an examination by a trustworthy radiographer should precede all explorations of the kidney and ureter. This will enable the surgeon to reach the calculus by the most suitable route, with the least possible amount of injury to the patient, and also to avoid many an unnecessary exploration on the one hand, or an incomplete operation on the other.

The rays may show calculi on both sides, either in the kidneys or ureters or both. Tenney (*Bost. Med. and Surg. Journ.*, February 4, 1904), from an analysis of 134 cases of ureteral calculi, found that they were multiple in one-eighth of the cases.

It should not be forgotten, however, that minute calculi, especially if they consist chiefly of uric acid, may be overlooked; and yet that these may be large enough to produce a fatal anuria. In rare cases, other things, such as blood, inspissated pus, or hydatid cysts, may do the same. Moreover, a positive X-ray result may mislead; cretaceous mesenteric glands, atheromatous patches in the arteries, phleboliths, calcifying centres in the pelvic ligaments, may occasionally lead to error. Fenwick has several times avoided these mistakes by passing into the ureter a bougie, which is opaque to the Röntgen rays (*Brit. Med. Journ.*, June 17, 1905). Leonard (*Lancet*, June 17, 1905), however, in 330 examinations for renal and ureteral calculi found the negative and positive errors to amount to less than 3 per cent. After 51 negative results with the rays, the surgeon discovered no stones upon exploration in 47; but stones were either passed or found at operation in 4 cases.

Abdominal and vaginal or rectal palpation of the ureter also should be practised more frequently for diagnostic and localising purposes. A prolapsed ovary has been mistaken for a calculus, however, but this mistake may be avoided by remembering that a calculus in the lower ureter will be placed nearer the surface and antero-externally to the vagina, whereas a prolapsed ovary is softer, and placed behind the vagina (Cullingworth, quoted by Morris, *loc. cit.*).

Intra-vesical palpation has served to discover a stone low down in several cases in the male and female (*vide infra*).

During operation upon the kidney and ureter, when there is any suspicion of the existence of a calculus or of any obstruction in the course of the ureter, it is always wise, if not imperative, to pass a ureteral catheter, bougie, or sound into the bladder, and also up into the pelvis of the kidney if the ureter only is exposed. The surgeon

may thus discover a second stone or some other obstruction which might be otherwise easily overlooked and render the operation incomplete or useless, whether the X-rays have been used or not.

Impaction of a calculus may take place at almost any point in the course of the ureter, although in most cases impaction occurs at or near one of the three following narrow places:—

(a) About two and a half inches below the hilum of the kidney, or about an inch below the junction of the renal pelvis and the ureter; here the diameter is about one-seventh of an inch (Deaver, *Ann. of Surg.*, vol. i. 1906, p. 733).

(b) Near the pelvic brim; here the diameter is about a quarter of an inch.

(c) At or near the vesical orifice; at the orifice the diameter is only one-tenth of an inch.

Tenney (*Bost. Med. and Surg. Journ.*, February 4, 1904) found that 35 stones were arrested at the upper constriction, 18 only at the middle, and 73 at the lower one. Bovée (*Washington Med. Annals*, 1905, vol. iv. p. 233) records 22, 17, and 18 at these sites respectively. Morris in 44 operation records found that 19 were impacted near the kidney, 10 at the pelvic brim, and 15 at the extremity of the ureter (*Lancet*, December, 1899). Since then the same authority has operated upon 4 and collected 12 more cases; in 11 of these 16 cases the impaction was at the lower end, and two others were found within three inches of the bladder.

It may, therefore, be concluded that most stones will be arrested at the lower constriction, and that many more will be found at the upper constriction than near the pelvic brim.

A calculus placed within the renal pelvis, acting as a ball valve, may obstruct the orifice of the ureter and even cause fatal anuria; but it must not be regarded as a "ureteral" calculus in the sense which is attributed to this word here.

Indications for Operation:—

(a) When the ureter of the only active kidney is obstructed and anuria exists, an immediate operation is imperative (*vide* p. 190).

(b) When only one ureter is obstructed, there is not the same urgent need for treatment, for it is a matter of common experience that many ureteral calculi are passed naturally. Leonard (*loc. cit.*) states that 26 of his 40 patients passed the stones which had been demonstrated by the X-rays. If a calculus is known to be small from an examination with the screen, and especially if it is shown to have descended between two examinations, and colic, but no complications, exist, expectant treatment may be tried for a few days, as recommended by Leonard. Large quantities of any alkaline mineral water may be given with the idea of increasing the volume and pressure of the urine, and urotropin or helmitol may be given with the object of keeping the urine aseptic. It is known that the kidney may resume its normal function after being obstructed more or less completely for weeks.

Immediate operation is demanded when—

(a) Another calculus, which is too large to travel along the ureter, is detected in either kidney, or the other ureter.

(b) When the calculus in the ureter is large and is really impacted and not merely passing down the duct. When the obstruction is

complete or nearly complete, as shown by the small volume of the urine and an examination of the separated urines, operation should not be delayed, lest the kidney be irreparably damaged.

(c) When there is evidence of any septic complication or of nephrec-tasis, as shown by fever, pyuria, and enlargement of the kidney or great tenderness in the region of the calculus.

Operation.—1. *Impaction of a Calculus at or above the Brim of the Pelvis.*—In these cases the ureter can be sufficiently exposed by prolonging the incision already made for exploring the kidney as above described (*vide p. 176*).

In some cases the dilatation of the ureter above the site of impaction will allow of the calculus being pushed gently along the ureter either up to the kidney or, at any rate, to some more accessible part of the ureter. Tuffier (Duplay and Réclus, *Traité de Chirurgie*, t. vii. 1892), during a lumbar nephro-lithotomy, in which examination of the kidney revealed no stone, detected a hard oval body about three centimetres long, where the ureter crossed the pelvic brim. The stone was movable and was pushed up into the pelvis of the kidney, and removed by an incision into the convex border. The patient recovered.

If the stone cannot be pushed up as far as the kidney, or is so tightly impacted that it cannot be moved, it should be removed through a longitudinal incision in the ureter. The incision in the ureter may be sutured with fine silk or catgut, passing through the outer coats, or it may be left without sutures. Deaver (*loc. cit.*) uses two layers of sutures: catgut for the deep layer and silk for the outer coats. Mitchell and Corson (*loc. cit.*) pass the sutures before incising the ureter. Should inflammatory thickening or ulceration of the ureter be present, it would seem wiser not to insert sutures. A number of successful cases, both with and without sutures, have been recorded. The following case, described by Dr. Kirkham (*Lancet*, March 16, 1899), is an illustrative one, and is, I believe, the first case in which a patient has been saved from death from suppression of urine by the removal of a calculus low down in the ureter:

The patient was 58. He had twice suffered from right renal colic, and had passed a small calculus. May 24, left renal colic came on. No urine was passed from this date till after the operation. May 30, the patient was drowsy, with prostration and muscular twitchings. Dr. Kirkham then explored the kidney in the hope that if no calculus was removed life might be saved by affording an outlet to the urine by an incision into the pelvis of the kidney. An incision was made from the tip of the last rib towards the anterior superior spine. No stone being found in the kidney, the exploration was continued along the ureter, in which a stone was distinctly felt about half an inch above where the ureter crosses the external iliac. There was a little difficulty in reaching the ureter in this part of its course, but after enlargement of the wound a calculus about the size of a date-stone was removed. A little urine escaped from the incision into the ureter. No sutures were placed in this. Half an hour after the operation an ounce and a half of urine was passed naturally. Very little escaped from the wound in the ureter, and the patient made an excellent recovery.

When it has not been possible to localise the calculus before the operation, experience shows that the lumbar incision is the best to adopt. In 28 out of 44 cases recorded by Henry Morris, this incision was used under the impression that the disease was renal, and in 25 of these cases the calculus was accessible. There is, therefore, a

fair chance of finding the calculus and also of removing it through this incision.

Moreover, the kidney can be examined and removed if necessary, and if the other kidney is known to be healthy. In three of the 25 cases quoted by Morris nephrectomy was adopted. In any case a fistula can be established, and the kidney given a chance to recover.

If the stone cannot be found in the upper ureter, it should be sought with the ureteral sound, passed through an incision in the renal pelvis.

Should the stone be thus localised, it may be removed at once by prolonging the incision, or by making a separate anterior wound, if the stone is in the pelvis; the liability of ventral hernia is thus diminished and an easier and more direct access obtained.

In some cases it may be wise to delay the removal of the calculus, for the latter may be passed naturally after a few days, when the kidney has resumed its normal function. The condition of the patient may be too critical to allow a prolongation of the operation, and the surgeon may then reluctantly remain content with establishing a temporary urinary fistula in the loin.

2. *Impaction of a Calculus in the Pelvic Portion of the Ureter.*—In the male, the greater part of the pelvic ureter can be exposed by a prolongation of the lumbar incision already made for exploring the kidney, as recommended by Morris (*vide* pp. 173, 176 and 192).

Should the patient, however, be fat, and the lumbar incision already very deep, this method will be found to be extremely difficult. In such cases, and also in the female, the abdomen should be opened by an incision in the semilunar line or through the rectus sheath. In most cases it will then be found possible to push the calculus along the dilated ureter up to or near the kidney, when its removal can be accomplished through the lumbar incision, and the abdominal wound closed. This plan was first carried out by Lane in the following case (*Lancet*, 1890, vol. ii. p. 967) :

A woman, aged 23, had had symptoms of renal stone for twenty years, but there was nothing to point to the fact that the stone was in the ureter and not in the kidney, except that, associated with her renal pain, she complained at times of pain in the lower part of the abdomen on the same side, which did not appear to be reflected. The kidney was explored by the lumbar incision, and nothing found either in this organ or in those parts of the ureter which could be reached from above or *per rectum*. The pain having returned with its original severity, the abdomen was opened along the left linea semilunaris, and in the portion of the ureter which had not been explored at the previous operation a small stone was felt. This was forced upwards along the ureter to the crest of the ilium, and by means of a small incision in the side the ureter was exposed and the stone removed. The aperture in the ureter was sewn up by a fine continuous silk suture. No leakage took place from the ureter, and the woman recovered completely, losing all her pain and discomfort.

Witherspoon (*New York Med. Journ.*, May 21, 1904) has modified Lane's method. Through the lower part of the rectus he opens the peritonæum and examines both ureters and kidneys, and having localised the stone, he sews up the peritonæum accurately, and peels it away from the parietes, so as to enable him to extract the stone extraperitonæally.

I strongly recommend this incision, but with modern methods of localisation, and of determining the condition of the other kidney, it will be rarely necessary to open the peritonæum for exploratory purposes.

Moreover, the fallacies of this method have been already dealt with (p. 193).

The rectus incision has the following advantages :

It gives a very good view, which is unspoilt by hæmorrhage. It is extra-peritonæal, at least as regards the incision into the ureter. It is not very difficult to anyone with a sound knowledge of anatomy. The risks of hernia and of injury of the cord are less than after the oblique inguinal incision mentioned below. Drainage is easily established.

The ureter is to be sought in the mesial aspect of the wound, attached to the displaced peritonæum. The finger of an assistant or a bougie in the rectum or vagina and a sound in the bladder may give valuable aid. Thus the stone may be more easily found, and the ureter containing it may be pushed upward into a more accessible position. Gentle endeavours may be made to push the stone upward into a more dilated, healthy, and visible part of the ureter. Care must be taken, however, not to use force, lest the ureter be damaged; in one of Israel's cases (quoted by Morris) the duct was torn across. Attempts to crush the stone are not likely to succeed, and may injure the ureter. The stone can rarely be pushed on into the bladder because of the very small size of the vesical orifice, and, moreover, it would be difficult to tell whether the calculus had really reached the interior of the bladder or had merely passed into the submucous parts of the ureter. Sutures are not essential, and sometimes it may be a very difficult and tedious task to insert them; but whenever possible they should be used, for the leakage may be at least diminished, if not prevented entirely, in some cases. The risks of extravasation and delay of recovery may thus be avoided. Mitchell and Corson pass the sutures before incising the ureter, and take advantage of the stone as a guide and support. Before sewing the longitudinal incision in the ureter, a bougie must be passed down into the bladder and up to the kidney. In any case drainage of the wound is essential, for it is difficult to close the tube accurately in the depth of the wound, and leakage may occur even after the most careful suturing.

Gibbon (*Ann. of Surg.*, 1906, vol. xliii. p. 742) has adopted a similar method except that he does not suture the parietal peritonæum until he has extracted the stone, which he pushes up into the extra-peritonæal wound by means of a finger within the peritonæal cavity. He records two cases in which he successfully adopted this method, after discovering ureteral stones during exploration, in patients who had been sent to him supposed to be suffering from appendicitis. The appendix and the stone were removed in each case, and both patients did well, but there is little doubt that it is safer to sew up the peritonæum (if opened at all) before incising a tube which has septic contents in most cases of calculous obstruction.

Mr. Betham Robinson (*Lancet*, vol. i. 1905, p. 495) has successfully removed a stone situated close to the bladder of a boy of only three years of age. He used an extra-peritonæal incision similar to the one commonly employed for tying the external iliac artery. From an experience of this and two successful cases in adults, he concludes that the operation is much easier in the child, because of the absence of much fat in the abdominal wall and the small size of the child's pelvis, with the abdominal position of the bladder, so that the finger in the rectum was able to push the ureter and the stone well up into the

wound. Care must be taken not to lacerate the thin peritonæum of the child.

Freyer (*Lancet*, vol. xi. 1903, p. 584) and a number of other surgeons have also used this method, and speak well of it.

Dr. Fowler (*Ann. of Surg.*, vol. xl. 1904, p. 943) recommends this incision even for stones impacted very low in the pelvis.

Sampson (*Ann. of Surg.*, 1905, vol. xli. p. 217) approaches the lower ureter through a low gridiron or muscular separation incision in the groin and recommends the adoption of either this or the incision through the rectus.

In no case is it wise or safe to remove a calculus from the ureter through the peritonæum, for however carefully the latter may be protected from soiling with urine during the operation, and however carefully and skilfully the surgeon may attempt to close the incision in the diseased ureter, it is the rule for the urine, which is usually septic in these cases, to leak at the line of suture. Therefore it is an accepted rule, that drainage of the neighbourhood of the sutures is essential to guard against probable urinary extravasation. Such drainage cannot be safely established across the peritonæum, and when the peritonæum covering the ureter is sewn up, extravasation may still occur into the undrained extra-peritonæal tissues and set up pelvic cellulitis.

These remarks are made with full knowledge that the trans-peritonæal method has been entirely successful in a few cases, of which the following is a brilliant instance, recorded by Mr. F. J. Steward (*Clin. Soc. Trans.*, vol. xxxiv.):

The patient was admitted for hæmaturia and painful micturition, which, in the absence of pain or tenderness over either kidney or ureter, were thought to be due to a vesical calculus. As the sound detected nothing, the bladder, after being distended with air, was opened above the pubes. Nothing was found in the bladder, but through its walls a stone could be felt in the lower part of the right ureter. As the stone could not be worked down towards the bladder, the wound was closed. Eight days later an incision about five inches long was made in the lower part of the right linea semilunaris, and the peritonæal sac opened. The stone was easily felt, and was gently manipulated up the ureter as far as a point a little above the iliac vessels. As it would go no further, the peritonæum and then the ureter were incised and the stone, weighing nine grains, removed. The ureter was then closed with a fine silk suture, taking up the outer coats only; the peritonæum was then sutured in like manner, and the wound closed, with the exception of a small part through which a gauze drain was brought. No leakage occurred, and the patient made a satisfactory recovery.

3. *Impaction at or near the Vesical Orifice.*—In these cases the symptoms may very closely resemble those of stone in the bladder or cystitis. Judicious use of the cystoscope and bimanual pelvic examination may prevent the error in some cases. The mistaken diagnosis may be confirmed by the use of the sound alone, for the projecting part of the calculus may be touched. Freyer (*loc. cit.*) relates three cases of this kind.

The vesical route is the best in these cases, *the urethra being dilated in the female*. Successful results have been recorded by Emmet, Berg, Richmond, Czerny, Sanger, Thornton, Freyer, and others. Millet evaginated the ureteral orifice through the female urethra, by means of a finger in the vagina, and he was then able to extract the stone (Deaver, *loc. cit.*).

In the male the stones are best removed by suprapubic cystotomy.—Morris refers to five cases in which this method was successfully adopted. Tuffier has also removed stones in this position twice by suprapubic cystotomy. Crawford (*Amer. Med.*, vol. ii. 1904, p. 791) succeeded in extracting a calculus measuring $1\frac{3}{8}$ inches in diameter in this way. Freyer (*loc. cit.*) removed ureteral stones in two cases through a perineal lithotomy wound, undertaken for the removal of vesical stones, for which the calculi had been mistaken, by the use of the sound.

After several attempts Freyer (*loc. cit.*) was able to grasp and remove a stone from the ureteral orifice of a man by means of a lithotrite, which was then used to crush it. The calculus had been localised by means of the cystoscope.

It may be necessary to incise the mucous membrane or even the muscular wall of the bladder in order to free the calculus, but as long as the incision is not carried upwards for more than an inch the peritonæum will not be endangered. While trying to grasp the stone with forceps, a finger placed in the vagina or rectum should be used to prevent the stone from slipping upwards out of reach.

4. *Impaction low in the Pelvis, but not accessible from the Bladder.*—Until lately it used to be believed that stones situated low down in the pelvis could not be reached or removed through the iliac or other extra-peritonæal route, especially in the female.

The experiences of Israel, Young (*loc. infra cit.*), Finney, Betham, Robinson, and others, have proved that it is possible to remove a calculus from any part of the ureter down to the bladder wall through an iliac incision. It may not be always wise to choose this route, however, for it may not be the easiest or the safest method to adopt in certain cases for various reasons. In most cases it should be adopted, however, because the kidney and ureter can be examined at the same time. Ceci records a fatal case in which he removed a calculus through the rectum; this route is not to be recommended on account of the danger of ascending suppurative nephritis.

The Vaginal Route.—Emmet, Cabot, Israel, Garceau, and others, have successfully removed ureteral calculi through the vagina. It may be suitable for some cases in which the calculus is not more than two inches from the bladder.

Garceau (*Boston Med. and Surg. Journ.*, April 21, 1904) removed a stone impacted about three inches from the vesical orifice by incising the anterior vaginal cul de sac, and pushing away the peritonæum from between the bladder and the uterus, and then everting the broad ligament backwards, and hooking the calculus and the ureter downwards and forwards towards the vagina. A small vaginal incision was then made, and the calculus squeezed out, and the incision was closed with sutures, which took up the outer coats of the ureter. The operation took only ten minutes, and was entirely successful, no fistula resulting. The stone was a large one, having a diameter of three-eighths of an inch.

This method carries the risk of pelvic cellulitis, which occurred in a case recorded by Freyer (*Lancet*, vol. ii. 1903, p. 584).

In this case Freyer was unable to extract the calculus, because it slipped up out of his reach; but it came away into the dressings. Pelvic cellulitis supervened and delayed the recovery of the patient.

A temporary or permanent uretero-vaginal fistula may also arise after this operation. Israel (quoted by Young), although he was able to remove two stones by this route, failed in two other cases, and had to resort to the iliac incision, which proved successful. Therefore Israel did not attempt the vaginal operation in his two next cases.

Fenwick (*Clin. Soc. Trans.*, vol. xx. p. 240) has removed a calculus located two to three inches from the bladder through a small transverse perinæal incision, but this method is not recommended for the reasons given by Young in his able article on the surgery of the lower ureter (*Ann. of Surg.*, 1903, vol. xxxvii. p. 682). He states that the wound is narrow and deep; and that Regnier failed to reach the stone, and had to adopt the iliac method. Moreover, the peritonæum may be opened unawares, and the kidney and ureter cannot be examined; and the incision in the latter cannot be sutured.

The Sacral Route.—Henry Morris (*Surgical Diseases of the Kidney and Ureter*, vol. vi. p. 469) in February, 1900, removed a calculus, which was impacted two to two and a half inches from the orifice of the left ureter, through the "sacral route." Morris considered the calculus to be too high for removal by the vaginal method. He made an incision five inches long parallel with, and to the left of, the vertebral spines, and two inches from the middle line. It extended from the level of the third sacral spine to a distance of one and a half inches beyond the tip of the coccyx. The gluteus maximus and the great sacro-sciatic ligament were divided and retracted. Bougies were inserted in the vagina and rectum, and a sound was passed into the bladder. "After some trouble the left ureter was found, and the part containing the impacted stone was pushed into the wound." The stone was removed, and three Lembert sutures were used to close the ureteral incision. A fistula lasted for nearly four weeks; but the patient made a good recovery.

In another case Mr. Morris adopted this method for the removal of the lower part of the ureter of a patient whose corresponding kidney and upper part of the ureter had been removed for calculous pyonephrosis three weeks earlier. The part of the ureter removed by the sacral route contained nine stones.

This method, which was first suggested by Cabot in 1892 (*Amer. Journ. Med. Sci.*, 1892, p. 43), deserves attention because it has been adopted and recommended by so eminent an authority as Henry Morris; but it is open to the following criticisms. It is unnecessarily severe, difficult, and destructive, and it does not allow a proper examination of the kidney and ureter, so that extensive disease of the one and a stricture of the other may be overlooked. It is practically certain that any stone in the pelvis can be reached either by the abdominal extra-peritonæal route or by the vaginal or vesical routes.

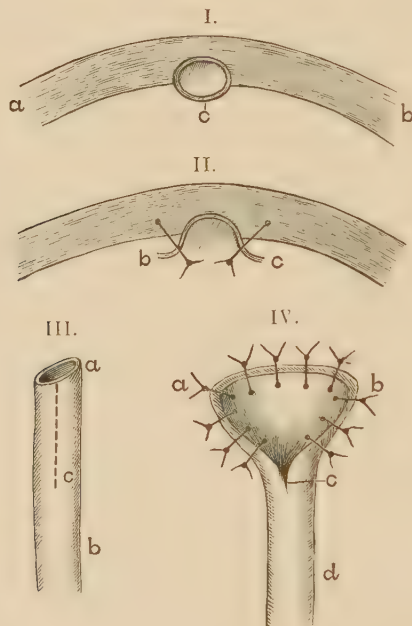
Prognosis.—Extra-peritonæal uretero-lithotomy is a very successful operation, which has a brilliant future. With earlier and more accurate diagnosis, the operation will not only have a lower mortality, but will also save more kidneys from destruction by long-continued backward pressure and sepsis.

Tenney (*loc. supra cit.*) gives the mortality of 23 in 122 cases. Fowler (*loc. cit.*) mentions three deaths in 21 operations, and Deaver (*loc. cit.*) two deaths in 25 cases.

In 44 cases recorded by Morris (*loc. cit.*) nephrectomy was necessary in four.

II. VALVULAR OBSTRUCTION.—Simon, in 1876, gave theoretical directions for the relief of this condition. The first successful operation was, however, performed by Fenger, of Chicago, in 1892. The method of dealing with the condition may be gathered from the following *résumé* of Fenger's case (*Ann. of Surg.*, vol. xx. 1894). The patient was a woman, aged 28, with intermittent hydro-nephrosis due to a movable kidney. The pelvis and calyces were first explored and no stone

FIG. 73.



Showing Küster's operation. (Morris.) I. Sac wall; c, transverse section of ureter. II. b, c, the ureter in transverse section, split on anterior side; at b and c, eleven sutures which connect the wings of the split ureter to the wall of the sac. III. a, the upper mouth of the ureter running in the wall of the sac, a, b; a, c, split line of the same in the anterior part of the canal. IV. The cleft walls of the canal pulled apart and fixed at a, b, c, inside the wall of the sac.

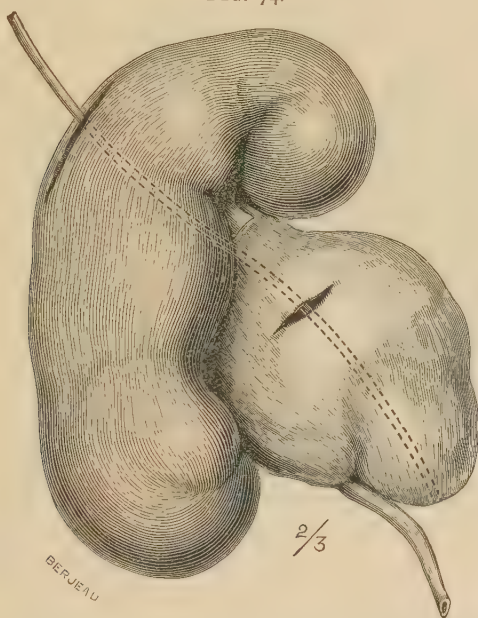
found. As the ureter could not be catheterised, a small opening was made in the posterior wall of the infundibulum, when a valvular obstruction was found at the upper end of the ureter where it joined the renal pelvis. The valve was divided vertically, and the ends of the longitudinal incision united by sutures, so as to convert the incision into a transverse one. The incision in the infundibulum was then closed with sutures, and the kidney fixed in the loin, a bougie being passed through the wound in the renal parenchyma and retained in position in the ureter for two days. The patient recovered without a fistula, and subsequently had no return of the hydronephrosis.

Morris (*loc. cit.*, vol. ii. p. 435) does not recommend leaving the bougie, for there is little fear of stenosis resulting, if the ureter be of normal calibre: "It delays healing, and it is liable to be followed by a temporary fistula. It is apt to excite ureteritis, and there may be marked difficulty in removing it owing to deposit of urinary salts upon it."

If the ureter be found to be adherent to the dilated pelvis, and opening into the latter too high for efficient drainage, a plastic operation should be undertaken. The valve or bridge between the lower end of the pelvis and the ureter should be incised from within the pelvis, which should be opened by a posterior vertical incision.

Recurrence of the malformation should be prevented by carefully

FIG. 74.



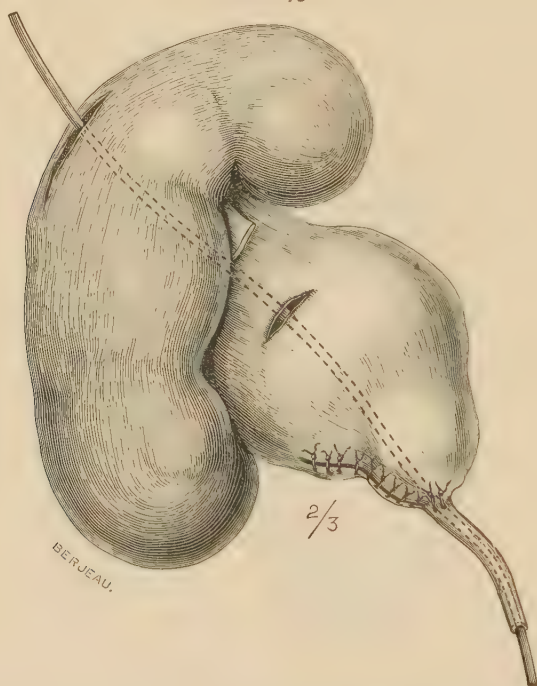
Abnormal position of ureter to hydronephrotic infundibulum of kidney before operation. (Morris.) The bougie could not be passed into the ureter through the kidney wound, therefore an incision was made in the pelvis.

suturing the edges of the incision in the septum in a longitudinal direction, as recommended by Mynter (*Ann. of Surg.*, December, 1893), or by sewing the flaps to the inner surface of the sac (Küster). The simplest way, however, is to join the extremities of the longitudinal wound and thus convert it into a transverse one, as recommended by Fenger and Morris. The exploratory incision in the pelvis should then be closed with fine catgut sutures, which should not pierce the mucous lining, and should be prepared to last for about twenty days, so that they may not become absorbed before firm union has occurred.

If the method recommended above is not practicable because the ureter is not adherent to the dependent part of the hydronephrotic sac, an incision may be made at the lowest point of the sac, and its edges

joined to a longitudinal wound made in the ureter. The sutures should only pierce the outer coats of the sac and ureter. This method is not applicable when a narrow stricture exists in the ureter below the lower end of the sac, and then a portion of the ureter may have to be resected and the healthy end joined to the lower part of the sac, as in Küster's classical case. Küster's patient had a hydronephrosis of his only kidney draining in the loin, and Küster found first a valvular and elevated ureteral orifice, which he slit open; then he discovered a slight stricture in the ureter 2 c.m. below the sac. As this was not remediable, it was resected, and the healthy end was

FIG. 75.



Ureter in its improved position to the infundibulum after resection of the upper end of the ureter, and its reunion with the renal pelvis. (Morris.)

attached to the lower end of the hydronephrotic sac, as shown in Fig. 73. It will be noticed that the outer surface of the ureter is attached to the denuded inner surface of the sac.

The patient ultimately improved wonderfully in his general health and comfort. The fistula closed, although pus was present in the urine six months later.

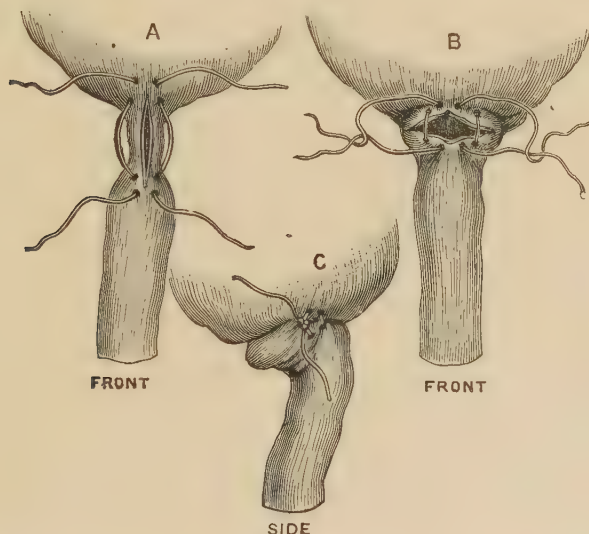
Figures (74 and 75) from Mr. Morris' well-known work illustrate his case, in which he slit open the pelvis from the point of insertion of the ureter to the lower end of the sac, and then joined the healthy end of the ureter to the margins of the lower part of the incision. The end of the ureter was enlarged by slitting to prevent subsequent contraction. Morris himself states that lateral anastomosis would do well for cases of this kind. Certainly it would be much simpler, and the

danger of leakage at the "angle of suture" would be avoided. The stump of the ureter attached to the pelvis could be turned in by a purse-string suture.

Morgan (*Ann. of Surg.*, 1902, vol. xxxvi. p. 528) has published a unique case of valvular obstruction situated about one and a half inches above the bladder. This malformation was probably due to kinking, which was again due to peri-ureteral adhesions, such as induce a similar condition in the œsophagus. Morgan divided the valve through an incision made extra-peritonæally into the pouch. A suprapubic cystotomy was performed to pass catheters into the ureter to prevent recurrence and establish drainage. The patient ultimately made a good recovery.

III. STRICTURE OF THE URETER.—Various plans have been adopted by different surgeons to remedy strictures of the ureter, the chief being

FIG. 76.



Illustrating Fenger's operation for stricture of the ureter. (Morris.)

the plastic method of Fenger (*loc. supra cit.*), dilatation by bougies (Alsberg), and resection of the strictured portion (Küster). The first of these plans only will be described here, as it will probably be found applicable to the greatest number of cases. Moreover, this method has been successfully carried out by Fenger, Morris, Mynter, and others.

The details of the operation can be very well made out by reference to the three illustrations in Fig. 76. The strictured portion of the ureter is first divided longitudinally; sutures of fine silk are then passed on either side of this in order to draw the two extremities of the incision together and thus convert it into a transverse one, after the manner of the Heineke-Mickulicz operation for stenosis of the pylorus. Further sutures, passing through the outer coats only, now bring the edges of the rest of the incision together, thus folding the ureter on itself to some extent.

The following short account of Fenger's case well illustrates the brilliant success of the operation:

"Traumatic stricture of ureter close to entrance into pelvis of kidney; intermittent pyonephrosis for twenty-four years; increased frequency of attacks; nephrotomy; no stone in sacculated kidney; ureteral entrance could not be found; longitudinal ureterotomy revealed stricture at upper end of ureter; longitudinal division of stricture and plastic operation on ureter; recovery without fistula."

Before performing any plastic operation upon the ureter or the pelvis, it is very important to decide (a) if the kidney is in a recoverable condition, and (b) if the ureter is patent throughout the rest of its course up and down. Much may have been learnt about the functional capacity of the kidney from an examination of the separated urines, but the only reliable evidence is an examination of the kidney from the wound. The patency of the ureter must be determined by means of a bougie or ureteral catheter. These must be used at the beginning of all plastic operations, and before completing all nephro-lithotomies and uretero-lithotomies. If these precautions are not taken the surgeon may waste time and energy in performing useless operations, or fail to relieve his patients by incomplete ones. It should be remembered that stones and strictures of the ureter are often associated. The stone may be either the result or the cause of the stricture. Carcinomatous stricture may develop at or near an impacted stone (Deaver, *loc. cit.*).

In cases of extensive or multiple strictures of the ureter, and in those due to tuberculous or malignant disease, nephro-ureterectomy may be the only suitable treatment if the other kidney is known to be sufficiently healthy. Failing this, a fistula may be established in the loin.

Ureteral Catheterisation and dilatation through the bladder has been successfully performed, and cases have been published by Kelly, Pawlik, Casper, and others. Morris condemns the treatment as a difficult, tedious, and painful process, which is moreover uncertain and revolting. Pawlik had to pass the instrument thirty times in his cases of pyonephrosis. Symptoms of fever and pain may be aggravated by each introduction.

Strictures of the lower ureter may be approached through an extra-peritonæal abdominal incision and treated in one of various ways.

Young (*Ann. of Surg.*, 1903, vol. xxxvii. p. 688), after removing a calculus impacted $1\frac{1}{2}$ cms. above the bladder, was able to dilate a stricture which had developed below the calculus. In another case of the same kind, Dr. Young removed a large calculus from the ureter just above the wall of the bladder. He then discovered an impervious intra-mural stricture which he was not able to dilate. He therefore exposed the lateral wall of the bladder from the same iliac wound, and having retracted the vas deferens, he opened the bladder. With the aid of digital counter-pressure at the ureteral orifice, he was able to force the point of a small urethral dilator into the bladder and then to divide the stricture from within the bladder by means of a long-handled scalpel. The patient made a rapid recovery, and the ureteral orifice was seen to be patent six months later by means of the cystoscope.

Israel (quoted by Young) having performed a nephro-lithotomy on a

woman, and discovered a stricture in the pelvic ureter, attempted to dilate the stricture from the bladder; but failing, he exposed the ureter extra-peritonæally, and found a stricture about 3 cms. long ending at the bladder wall. He then resected the stricture and joined the healthy end of the ureter to an incision made on a sound high up on the posterior wall of the bladder. The ureter was cut obliquely, and its mucous membrane sutured to that of the bladder at one angle of the wound, which was then closed. The lumbar fistula, which had existed for eight months, soon closed. Before it closed Israel proved that fluid introduced into the bladder did not flow back through the new ureteral orifice, but a catheter could be passed from the fistula along the ureter into the bladder.

Extra-peritonæal uretero-vesical anastomosis is far preferable to making a uretero-vaginal fistula for the purpose of dilating the stricture, for the fistula may not close, and the stricture may recontract. Nephrectomy is better than a permanent urinary fistula either in the loin or vagina, if the other kidney is healthy.

Aberrant renal vessels causing and obstructing the ureter may be ligatured and divided. Morris (*Lancet*, 1905, vol. ii. p. 158) discovered this condition in a woman whose symptoms had not been relieved by a nephropexy performed elsewhere four years earlier. Sixteen calculi were also discovered in the kidney, and were probably secondary to the ureteral obstruction.

B. Injuries to the Ureter.—These may be met with either in the form of traumatic ruptures, or of accidental division or removal of a piece of the ureter during the course of certain abdominal operations, such as hysterectomy or the removal of a pelvic tumour.

Traumatic rupture of the ureter has not yet been treated by direct suture. This is owing doubtless to the extreme difficulty in the diagnosis of this condition in the early stages, for most of the cases have not been recognised until an accumulation of urine, blood, or pus has formed and has been opened. The tumour due to the accumulation may not be noticed for some time, two to three weeks (Stanley, Page, Barker, Hicks), thirty-nine days (Croft), and in one case (Stanley's) not until seven weeks after the injury.

Mr. Henry Morris (vol. ii. p. 330) was only able to discover records of 12 cases of rupture of the ureter as distinguished from rupture of the renal pelvis. Should a traumatic rupture be discovered during an exploration, it should be treated by suture or anastomosis.

The accumulated fluid in the loin has been aspirated in some cases several times with ultimate recovery, but it is questionable whether the absence of reaccumulation has not been due to atrophy of the kidney.

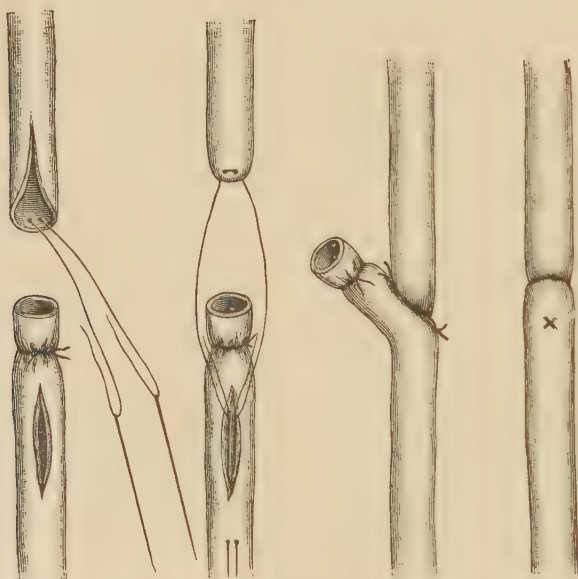
Lumbar incision is far preferable, and thus drainage at least will be established to prevent further extravasation and suppuration. In some of these late cases it may be possible to perform a plastic operation on the ureter. If it be known that the opposite kidney is in good working order, a secondary nephrectomy may be performed for suppuration in and around the kidney, or for persistent fistula.

Primary nephrectomy is not justifiable, for the kidney and ureter may recover their functions, and knowledge is first needed concerning the secreting power of the other kidney, if any.

For accidental division or removal of a piece of the ureter during the course of an abdominal operation, a very large number of different operations have been performed. It is impossible here to mention or describe all these operations. An attempt will, however, be made to indicate the methods which are likely to be found most suitable to the various conditions that may be met with.

In the great majority of instances it will be found possible to directly unite the divided ends of the ureter. The results that have so far attended the various methods of bringing this about clearly show that it should be done wherever possible. Bovée (*Ann. of Surg.*, August, 1900) mentions twenty-seven published cases with only two deaths, and not in one was there failure to unite. If the ureter has been

FIG. 77.



Uretero-ureterostomy: Van Hook's method. (Morris.)

simply divided without loss of substance, and if both the ends are accessible, and the upper end will not reach the bladder, then, because it is the most simple method to carry out, and because it is the least likely to be followed by stricture, the following operation, devised by Van Hook (*vide* Fig. 77), should be performed. The following are the steps of the operation as given by Fenger (*loc. supra cit.*):

“(1) Ligate the lower portion of the tube one-eighth or one-fourth of an inch from the free end. Silk or catgut may be used. Make with fine sharp-pointed scissors a longitudinal incision, twice as long as the diameter of the ureter, in the wall of the lower end, one-fourth of an inch below the ligature.

“(2) Make an incision with the scissors in the upper portion of the ureter, beginning at the open end of the duct and carrying it up one-fourth of an inch. This incision ensures the patency of the tube.

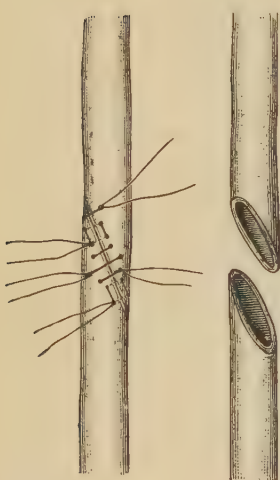
“(3) Pass two very small cambric sewing needles armed with one

thread of sterilised catgut through the wall of the upper end of the ureter, one-eighth of an inch from the extremity, from within outward, the needles being from one-sixteenth to one-eighth of an inch apart, and equidistant from the end of the duct. It will be seen that the loop of catgut between the needles firmly grasps the upper end of the ureter.

“(4) These needles are now carried through the slit in the side of the lower end of the ureter into and down the tube for one-half an inch, where they are pushed through the wall of the duct side by side.

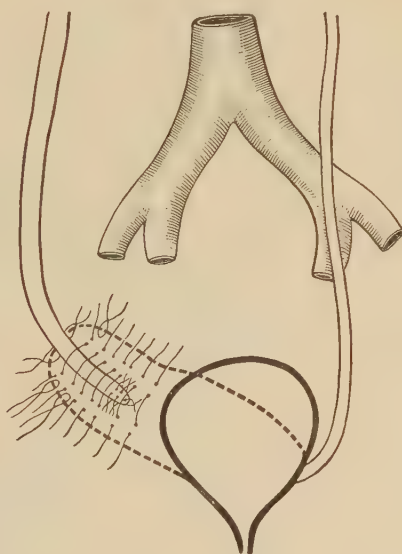
“(5) It will now be seen that traction upon this catgut loop passing through the wall of the ureter will draw the upper fragment of the duct

FIG. 78.



Uretero-ureterostomy. To illustrate the oblique method of Bovée. (Morris.)

FIG. 79.



Implantation of the ureter into the bladder (Witzel's method). The dotted lines show the bladder pulled into its new position with the ureter sutured into it. (Morris.)

into the lower portion. This being done, the ends of the loop are tied together securely, and as the catgut will be absorbed in a few days, calculi do not form to obstruct the passage of the urine.

“(6) The ureter is now enveloped carefully with peritonæum.”

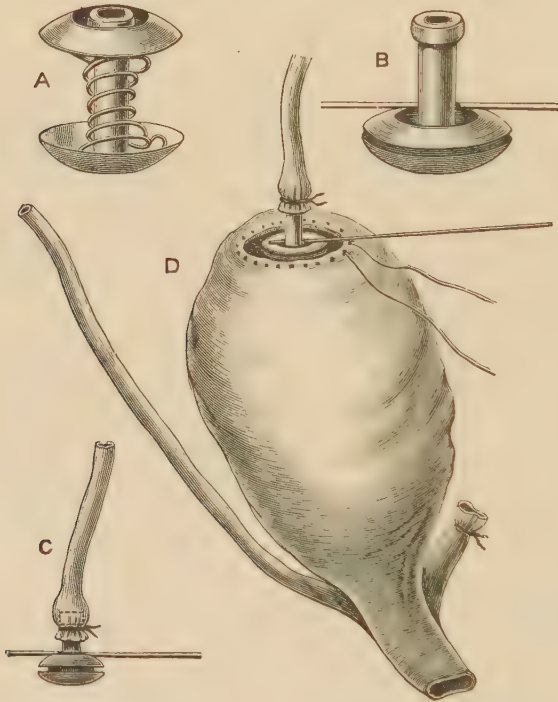
If, however, a portion of the ureter has been accidentally removed, and the upper end will not reach the bladder, it will probably be found that there will not be sufficient length of ureter available for performing Van Hook's operation. In this case the ends must be united by end-to-end suture, or by the oblique method of Bovée (*vide* Fig. 78). Stricture is not so likely to follow as after transverse end-to-end or end-in-end methods of Schopf and Poggi respectively.

Kelly (*Journ. Amer. Med. Assoc.*, Oct. 6th, 1900) has used a hammer similar to the one introduced by Halstead for gall duct operations. Near the end of the hammer there is a circular groove over which the

distal end of the ureter is temporarily tied. This may be found useful in anastomosis of the lower ureter.

Uretero-Vesical Grafting.—Should it be found that the upper end of the divided ureter will reach the bladder, implantation into this organ is preferable to all other procedures. This may be carried out by some modification of the method of Paoli and Busachi (*Annales des Maladies des Organes Genito-urinaires*, 1888), which consists in splitting the distal end of the ureter and uniting it by sutures to an incision in the bladder, or by a modification of the operation of Van Hook for uretero-ureterostomy, the cut end of the ureter being invaginated into

FIG. 80.



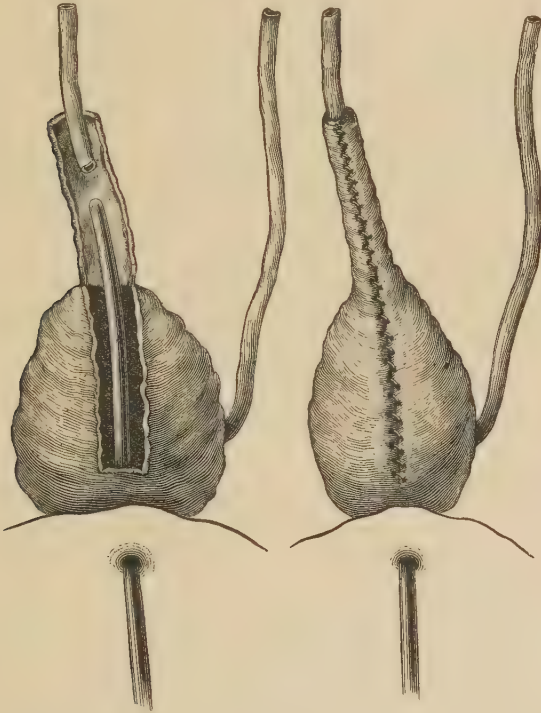
Technique of the grafting of the ureter on to the bladder with Boari's button. (Morris.) A, Enlarged view of button; B, Enlarged view of button, showing the spring compressed by the stiletto; C, The ureter fastened on to the button; D, The grafting on to the bladder by means of the button.

the bladder. This method has been adopted by Penrose and others (*Med. News*, vol. lxiv. 1894, p. 470). If possible the operation should be performed extra-peritonæally as in Witzel's operation (*Centralblatt für Gynakologie*, 1896, No. ii. p. 289). Witzel displaced and fixed the bladder into the iliac fossa, in order to enable him to bury the ureter for a distance 4 cm. in the bladder wall as shown in the figure. The mucous membranes of the incision in the bladder and of the oblique opening in the ureter were joined with interrupted catgut sutures, and the external coats were also joined with sutures (*Vide* Fig. 79).

In some cases Boari's* button, if available, may shorten the duration of the operation, but the button has to be removed later by the urethra in the female and supra-pubically in the male.

Boari (*loc. cit.*) has described and figured an ingenious plan of raising an extra-peritonæal flap from the anterior wall of the bladder and joining its edges, and implanting the ureter into the tube thus formed. This method may be found useful when displacement of the bladder is not enough to allow of union without tension. Van Hook has

FIG. 81.



Boari's operation. A flap from the anterior wall of the bladder is used as a substitute for the lower part of the ureter. (Morris.)

described a similar method; the ureter had been previously implanted upon the skin of the abdomen.

Finally, should such a length of ureter have been removed as to render both direct union of the two ends and implantation into the bladder impossible, the proximal end must be either implanted into the bowel or on the skin. The results of both these plans have so far been on the whole extremely unsatisfactory, owing to infection of the ureter and kidney in the case of implantation into the bowel, and to discomfort and constant irritation of the skin when the implantation is made on the skin. For these reasons a secondary nephrectomy will often be necessary in such cases.

* *Ann. des Malad. des Organ. Genito-urinaires*, 1896, p. 1.

CHAPTER V.

OPERATIONS ON THE INTESTINES.

ACUTE INTESTINAL OBSTRUCTION. — APPENDICITIS. — INFLAMMATION OF MECKEL'S DIVERTICULUM. — PERFORATING ULCER OF STOMACH—OF DUODENUM —OF INTESTINE AFTER TYPHOID FEVER.—SUPPURATIVE PERITONITIS. — TUBERCULAR PERITONITIS. — ENTEROSTOMY.—FORMATION OF ARTIFICIAL ANUS.—SUTURE OF INTESTINE.—RESECTION OF INTESTINE. —ENTERECTOMY.—COLECTOMY.—INTESTINAL ANASTOMOSIS AND SHORT CIRCUITING. — INTESTINAL OCCLUSION. — ENTEROPLASTY. — CLOSURE OF ARTIFICIAL ANUS AND FÆCAL FISTULA.

ACUTE INTESTINAL OBSTRUCTION.

CONSIDERED generally, without reference to the causation of the obstruction, the successful treatment of acute intestinal obstruction depends largely on two points: (a) The Question of Operation, and (b) The Question of the Extent of Interference that is indicated in any given Case.

(a) The Question of Operation.—Although cases of so-called "spontaneous cure" have from time to time been recorded, the number of these is so small, and the correctness of the diagnosis in many of them so doubtful, that for all practical purposes it is wiser to leave them entirely out of consideration. For, apart from these and the small number of cases of intussusception that have survived the sloughing of the intussusceptum, as Sir F. Treves says, "there is no avoiding the fact that acute intestinal obstruction, if unrelieved, ends in death" (*Intestinal Obstruction*, p. 475). This being so, it clearly becomes the duty of the surgeon to operate on every case of acute intestinal obstruction. The operation, moreover, should be performed at the earliest possible moment after the diagnosis has been made, for, serious as the operation is in itself, it is not nearly so serious as delay, since the mortality rises extremely rapidly as the period between the onset of the symptoms and the time of operation increases. Neither should uncertainty of diagnosis be allowed to delay the operation, for of the many conditions that simulate acute intestinal obstruction—*e.g.*, appendicitis, peritonitis from different causes, thrombosis of mesenteric veins, acute pancreatitis, enteritis, &c.—in some an operation may be beneficial, while as to the others it would be better that an exploratory

operation, as long as it is done by skilled hands, took place needlessly than that a remediable condition should be left untouched. Here, again, the valuable opinion of Sir F. Treves may be quoted. He says: "Operation in these cases is too often regarded as a *last* resource. It should be the *first* resource, as it certainly is the *only* resource."

The mortality of all cases of acute intestinal obstruction, as shown by Gibson (*Ann. of Surg.*, Oct. 1900) in a collection of cases operated upon between 1888 and 1898, is about 47 per cent., his list including 646 cases with 312 deaths; and although this is without doubt a vast improvement upon former times, it is still to be hoped that in the near future earlier recognition and more immediate operation will do much to bring about still further improvement. Even then the mortality will probably always be high, and this owing to the frequently complicated nature of the cause of the obstruction, the peculiar vitality of the parts which have to be handled, and the readiness with which these pass into a condition beyond recovery. Bearing in mind, however, the essentially fatal character of the condition, apart from relief by operation, every successful operation should be looked upon rather as a life saved, than every fatal one as a life lost. The results have considerably improved in the last few years.

(b) **The Extent of Interference that is indicated in a given Case.**—The operation must be according to the state of the patient. These cases of acute intestinal obstruction are not to be grouped together as all equally fit for operation, or as all certain to be relieved by operation as long as this is undertaken early. In some the condition of the patient is good, the abdomen is undistended and a prolonged search may be made. In others a precisely opposite condition is present, any prolonged exploration is out of the question, and all that can be done, if the cause is not found at once, is to open one of the most distended coils, as low down as possible, and drain the intestines (*vide infra*).

I propose to describe the **operation** generally first, and then to allude to its **application to the chief forms of acute intestinal obstruction**.

Operation.—The bladder is first emptied, and the abdominal wall shaved and cleansed. A water-bed should be filled with *hot* water, and if the patient's condition is bad, a hot port wine enema should be given.

The question of anæsthetics in these cases is a very important one, and should be well considered. The impeded respiration due to the abdominal distension is liable to make the administration of a general anæsthetic difficult and dangerous. The tendency to vomit is another grave danger, a sudden attack during the administration having frequently caused immediate death from choking.

Apart from these two considerations, the administration of a general anæsthetic seems to have special dangers of its own in cases of acute intestinal obstruction, for it undoubtedly often produces a complete and sudden change in the whole aspect of a case, a patient thought to be in good condition and well able to bear an operation becoming suddenly moribund within a few minutes of the commencement of the administration.

For all these reasons it is advisable, wherever possible, and especially in very bad cases, to make use of local anæsthesia only, the

infiltration method of Schleich with cocaine, or β eucaine, being the most suitable.

Should it, however, be deemed inadvisable to operate without general anæsthesia, the stomach should be previously washed out if vomiting has been severe, and saline infusions, either intra-venous or into the cellular tissue of the axilla, should be made during the preparation for the operation, and repeated or continuous infusion may be of great benefit after the operation.

The operation to be performed will necessarily vary according to the general condition of the patient, and the mode of procedure will be described under two heads: (A) **Early Cases, or where the condition of the patient is good**; and (B) **Late Cases, or where the condition of the patient is very serious**.

A. Early Cases.—The surgeon makes an incision five inches long through the right rectus muscle close to the middle line, and beginning two inches above the level of the umbilicus.* The anterior wall of the rectus sheath is incised, and one of its edges is separated from the muscle (Winslow); the muscle fibres are then either separated or drawn outwards; the transversalis fascia and the peritonæum are then separated from the deep surface of the rectus, and incised with care.

I strongly advise the surgeon to give himself plenty of room, so as to quickly get his hand in and explore efficiently. A short median incision below the umbilicus, and the introduction of a couple of fingers, is usually futile. The abdominal wall in these cases is not thinned and overstretched as in ovariectomy; hence, if inadequately opened, it grips the hand most embarrassingly. If the case has been allowed to go on until the intestines are distended, the search for the cause of the mischief will be rendered all the more difficult, and there must be sufficient room to introduce the hand freely. If an assistant skilfully keeps the edges of the wound together where this is not occupied by the inserted wrist, the intestines will not escape.

The peritonæum should always be well lifted up before it is opened, especially if there is distended bowel beneath. The opening is then enlarged with blunt-pointed scissors, two fingers with the palmar aspect turned upwards serving now as the best director.

The late Mr. Greig Smith advised, where the peritonæum is thin, that it be pinched up between the finger and thumb, and rolled about to see that no bowel is included.†

The surgeon should now decide which mode of exploration he will make use of. The following is as useful as any: If the parts are not much distended, three possible sites of strangulation should be first looked to. (1) The cæcum,‡ which will give twofold evidence, first, its

* In those extremely rare cases where the obstruction can be localised to one or other side of the abdomen, a lateral incision may be made use of, either over the swelling, if any be present, or in the linea semilunaris.

† If much fluid is present, it now often shows itself through the peritonæum.

‡ If the cæcum can be made out to be empty, tracing up empty coils from this will very likely lead to the obstruction. The more marked the evidence of collapsed small intestine, the greater the probability of the obstruction being high up, and the less fit the case for enterostomy (p. 344) (R. Jones, *Brit. Med. Journ.*, vol. i. 1894, p. 1123). In this case a band was found and successfully dealt with. Here the obstruction had been incomplete at first, one of incarceration followed by strangulation. I have mentioned a similar successful case on p. 350.

distension or emptiness telling whether the obstruction is above or below it; and secondly, the state of its appendix, whether normal or adherent, whether empty or containing some concretion. (2) Next, the internal inguinal, the femoral, and obturator rings are explored, to make sure that no tiny hernia exists, imperceptible from the outside. The fingers are next swept upwards towards the (3) umbilicus, in the hope of finding one of the diverticular bands mentioned at p. 266. If, up to this, the search has been fruitless, the brim of the pelvis is next examined, as bands of omenta are often fixed hereabouts, and also because, in women, local peritonitis, originating about the uterus or its appendages, and, in either sex, about the appendix cæci, is, not infrequently, the cause of the obstruction. If an empty coil of small intestine be fortunately discovered, it should be followed up to the obstruction, which will probably be not far away. This method is far easier than following a distended coil.

If the search fail—and it often will when distension is present, embarrassing the fingers in their movements, and obscuring the relation of parts—one or two of the loops which lie nearest to the wound should be carefully scrutinised.* These should be followed in the direction of increasing congestion and distension, thus leading to the obstruction. Fixity of a coil may be another aid. Where there is ground to believe that the case may be one of acute supervening upon chronic obstruction, the sigmoid and colon should be first investigated.

If this prove fruitless in cases where there is not much distension, the plan adopted by Mr. Cripps (*Clin. Soc. Trans.*, vol. xi. p. 225) is the simplest—i.e., to draw out some inches of intestine at a time, bit by bit, from the upper part of the wound, passing it in again into the belly through the lower part, in such a way that at no time are more than five or six inches of intestine exposed. After drawing out and replacing some feet of intestine in this way, it is probable that, owing to the increasing congestion or resistance, the surgeon will reach the obstruction.† This is, however, a tedious method, and one only to be adopted when the condition of the patient is good.

An assistant should hold the coil from which the surgeon starts in the lower angle of the wound under a hot sponge, so as to save the surgeon going over the ground a second time.

If a search for ten minutes has failed‡ to find the cause of obstruction the following courses remain open: (α) Kummell's plan of allowing the small intestines to prolapse under hot aseptic towels; (β) emptying the most distended coil, and either closing the opening later, or (γ) inserting in it a Paul's tube; (δ) "short-circuiting."

* The late Mr. Greig Smith said that as the most distended coils will rise nearest the surface, and the greater amount of bowel is within three inches of the umbilicus, there is a probability that the most dilated coils will be in sight.

† If he find that the bowel is getting healthier and emptier, the surgeon must reverse the direction of his search.

‡ "The difficulty of finding the obstruction in some cases is well shown by Madelung, who, in several cases where the seat of obstruction could not be located during life requested the pathologist, when he made the post-mortems, to locate the obstruction by introducing his hand through an incision, allowing him from ten to twenty minutes for the exploration; in every instance he failed to find the obstruction within the specified time" (Senn, *loc. supra cit.*).

(a) The objection to this method is, of course, that it is often exceedingly difficult to get the distended coils back into their home, and that the necessary manipulations and exposure must produce shock, and may inflict serious damage. If, however, the condition of the patient is satisfactory and the amount of distension not great, it is, if done properly, and with care to prevent undue exposure of, and damage to, the intestines, perhaps the wisest course to pursue. This practice is, moreover, recommended by no less an authority than Sir F. Treves, who considers that the damage done to the intestines, by the amount of exposure necessary, is probably less than that caused by prolonged manipulations within the abdominal cavity. The abdominal incision should be made very free, and the intestines then allowed to escape between smooth-surfaced sterile towels, wrung out of salt solution at a temperature of 110° F. In this way the intestines can be immediately covered with the towels, and the further search for the cause of obstruction conducted with very little exposure or interference. Usually the seat of obstruction will be quickly indicated by fixity of some loop of intestine, which thus will not leave the abdomen.

(β) Should, however, the amount of distension be considerable, it is wiser to relieve this condition before proceeding further. To this end a different method must be adopted according to the seat of greatest distension. Should this be the large intestine, for instance, in a case of volvulus, the distended loop may be emptied, either by oblique puncture with a very fine hydrocele trocar if, which is rare, they contain only gas, or by incision if liquid fæces are present as well. Both these steps are often disappointing. Two conditions must be present to allow puncture with the finest hydrocele trocar to be safe. The coats of the intestine must be sufficiently healthy, neither infiltrated nor paralysed, to allow the peritoneal and muscular coats to close the opening in the mucous by gliding over it, otherwise a fatal leakage will take place *guttatim* unless every puncture is closed by a fine parietal suture. The second condition is, that gas only must be present; liquid fæces being almost invariably present as well. A wiser course is to incise and evacuate the most distended coils. The patient being turned on to one side, the most distended loop is drawn out over a basin, incised parallel to its long axis at a point most distant from the mesentery, the rest of the coils being kept within the abdomen, and the one withdrawn carefully isolated by tampons of iodoform gauze or hot aseptic towels. As the escape of gas and fluids, owing to the paralysis of the intestine, will probably be very slow, it will be wise to follow Dr. Senn, and "resort to pouring out the contents, as it were, by seizing the gut several feet above and below the incision, and elevating it," a large quantity of fluid fæces being thus poured out. This emptying of distended coils will not only facilitate reduction, but, as first urged by the late Mr. Greig Smith (*Abdom. Surg.*, p. 436), it will diminish the harmful effects of a greatly distended abdomen, viz., dyspnoea, palpitation, and abdominal shock, and, as regards the bowels themselves, the danger of continued distension, paralysis, and absorption of toxic products. When the evacuation has been made as complete as possible, the next step will depend upon the condition of the patient. If this be good, and the relief of the distension has been sufficient to

justify further exploration, the surgeon closes his incision in the intestine by Lembert's sutures, taking care to effect real inversion of the edges, and, leaving one or two of the sutures long, keeps this bit of intestine outside, entrusted to an assistant, while he continues his search for the cause of the obstruction. If this be found and removed, the opened and sutured part of the intestine must again be inspected, and its exact closure made sure of before it is returned; any sutures left long having been first cut short. Before finally closing the wound the question of cleansing the peritonæal cavity, irrigation, and the insertion of a drain into Douglas's pouch may arise.

If, on the other hand, it is found that the small intestine is the seat of most distension, then very little advantage will be gained by either puncture or incision, for the acute flexures caused by the distension will prevent more than a very small portion of the gut being emptied by each incision. In this case it is wiser to drain the intestine for a time by performing enterostomy, as described below (p. 344), and to search for and, if possible, remove the cause of obstruction after the worst of the distension has been relieved.

(γ and δ) Where the patient's condition makes any further search impossible, or where there is great distension, a temporary or permanent artificial anus must be made, or else "short-circuiting" must be performed.

As the last can very rarely help us in acute intestinal obstruction, I will first dispose of this subject. It will be remembered that I am speaking of short-circuiting as one of the courses open to a surgeon when he fails to find the cause of an acute intestinal obstruction, or rather, of an acute supervening upon a chronic obstruction. It is evident that it is only to a few cases that this method is suitable—*e.g.*, cases of matting together of coils of small intestine, as after previous mischief set up by a mesenteric gland, or appendicitis. In such cases if there is inextricable matting but no recent inflammatory changes and nothing like gangrene, a coil of the distended small intestine may be short-circuited to the most conveniently placed piece of large intestine. This is effected by the use of a Mayo-Robson's bobbin, Murphy's button, according to the surgeon's familiarity with each, and the time at his disposal. In the majority of cases where the surgeon cannot find the cause, some part of the small intestine will be suffering not from chronic matting as above, but from the pressure effects of some band, orifice in the omentum, &c., and softening, or even gangrene, may be impending; then a safer and better plan to relieve the distended intestine will be by performing enterostomy as described below, by fixing in an enterostomy tube,* or puncturing with a large trocar and cannula (p. 349) one of the most distended coils, this being first withdrawn and completely isolated with sterilised towels or iodoform gauze. While the distension is being relieved the parietal wound may be sutured, and the knuckle of projecting bowel attached by a few points to the edges of the wound.

The peritonæal sac must be next cleansed of any fluids, and above all

* I have recorded, page 350, a case in which this treatment saved the life of a patient suffering from strangulation of the small intestine (localised gangrene having set in) by a band.

of any discharges, either by sponges introduced on large Spencer Wells's forceps down into the pelvis and along the costo-vertebral furrows, or by flushing with a hot solution of boracic acid (2 per cent.) or $\frac{1}{3}$ per cent. of salicylic acid, in boiled water; pints of this being introduced by an irrigating tube. After the flushing, sponges are again used, and a drainage tube* inserted. Drainage is always to be employed when the peritonæal sac has been contaminated. Further details are given at p. 303.

The opening in the abdominal walls is then rapidly closed with sutures of wire, or silk or fishing gut, material of sufficient stoutness being provided if any tension is present. Care should be taken to include the parietal peritonæum, and, as the sutures are inserted, to prevent any blood entering the cavity of the peritonæum. In early and favourable cases the wound may be sewn up in layers in the overlapping manner recommended at p. 103.

B. Late Cases.—Here the condition of the patient will not allow of any but the briefest operation. A small incision, two inches long, is made in the median line below the umbilicus. On opening the peritonæum, two fingers are introduced and carefully feel for the most distended coil within reach, and bring this up into the incision. This must now be opened and an artificial anus formed as described below at p. 347.

It may happen that this plan will result in the opening of a coil too high above the obstruction, or that the obstructed portion of intestine is already gangrenous, and in either of these cases the result may be fatal. On the other hand, it may be urged that in these extreme cases, further interference would be almost certainly fatal, even though the obstruction were relieved, and, moreover, that the most distended coils of intestine usually rise to the surface and are situated close to the umbilicus; and, finally, that a few lives have certainly been saved by this means.

Having spoken of the operation generally, I shall next refer to a few practical points connected with the chief causes of obstruction individually.

I. Strangulation by Bands and through Apertures.†

A. Bands. 1. *Adventitious Peritonæal Bands.*—Perhaps there has been a history of peritonitis, starting possibly from the appendix, the uterus and appendages, or a mesenteric gland. These bands are usually attached by one end to the mesentery. 2. *Omental Bands.*—Here some part of the lower end of the omentum has become adherent to the brim of the pelvis, a hernial sac, the uterine appendages, the cæcum, or a tuberculous mesenteric gland. 3. *Meckel's Diverticulum.*‡—This is usually met with in young subjects. Tubular or cord-like, it will be found attached at one end to the ileum, within three feet of the cæcum, at the other near the umbilicus, or to the mesentery or intestine.

* An indiarubber tube, which has several perforations and a strand of gauze in its lumen, is wrapped in antiseptic or sterile gauze.

† Sir F. Treves (*Intest. Obstruct.*, p. 13; *Diet. of Surg.*, vol. ii. p. 802) groups these together from the similarity of their obstruction and their close resemblance to strangulated hernia.

‡ For an account of other surgical conditions due to Meckel's diverticulum, *vide infra*, pp. 268 and 313.

Under this arch small intestine is very liable to slip. In other cases one end is free, and ensnares or knots up a loop of intestine. 4. *Some Normal Structure abnormally attached, e.g., the Fallopian Tube or the Appendix.**

In most cases bands, when found, are not difficult to deal with. If they do not give way to the finger as attempts are made to hook them up, they should be divided between two ligatures of silk. Occasionally transfixion is required. When one band has been discovered, the possibility of a second, attached to the pelvic brim, must always be remembered. In Gibson's list of cases there are 186 of obstruction by bands, and in no less than thirty-three of these there was a record of more than one band being present, and it is probable that the proportion is even higher than this.

Two other points connected with bands must be remembered: one, that if they are vascular both ends should be secured; the other, that on the division of the band the piece of intestine which has been released may be found to be gangrenous or even perforated, and allowing its contents to escape into the peritonæal sac. The intestine must then be brought outside and drained, and the peritonæal sac cleansed if possible (p. 319).

Every band should be resected as closely to its attached points as is safe, to prevent any recurrence of the trouble.

About three years ago one of us operated upon a boy of six years of age at the East London Hospital for acute intestinal obstruction. The symptoms had come on quite suddenly four days earlier with severe pain to the right of the middle line of the abdomen. Constipation had been complete and vomiting frequent, biliary but not foul fluid being brought up. The abdomen was slightly distended, especially in the middle line, where three large coils could be observed, after flicking the abdomen with a wet towel and watching for a few minutes. The appearance of the coils coincided with colicky pain and vomiting. It was therefore concluded that the obstruction was probably a band high up in the small intestine, and the fact that hardly any urine had been passed for twenty-four hours confirmed this diagnosis. An incision was made through the middle of the right rectus muscle, and a strand of great omentum was discovered stretched over a piece of the jejunum and adherent at its end to the right side of the mesentery, whence it tore off, leading to the rupture a caseous mesenteric gland. The piece of omentum was ligatured and excised and the abscess scraped out, and the peritonæum sutured over its site. Multiple miliary tubercles were seen upon the coils of small intestine, and the great omentum was shrivelled hard and diseased. The constriction upon the jejunum was tight, but it had not produced any gangrene, but only a white semi-circle, which was inverted by suture. The distended coils were compressed and some of their contents were seen to pass into and distend the collapsed intestines *below*. The child recovered without interruption, and two years later he had no sign of tuberculous peritonitis, but only attended for treatment of paralytic talipes for which he had been under treatment before the sudden onset of his more serious illness.

In striking contrast with this case was a more recent one, under the care of Dr. Frederick Taylor, at Guy's Hospital. The patient was a woman of 37, who gave a history of a severe attack of appendicitis eleven years earlier. Her fatal illness came on very suddenly. As she was stooping forwards she felt "something slip inside" her abdomen, and she was immediately seized with severe abdominal pain and vomiting, followed by collapse and complete obstruction. One of us first saw her on the fourth day of her disease, and soon after her admission. Upon opening the abdomen through the left rectus, sanious fluid escaped, and very distended congested coils of small intestine presented, but the site and nature of the

* One classification of bands useful to the operator is into those easily found and those which are inaccessible.

obstruction could not be discovered until the incision was freely enlarged. About eight feet of small intestine were seen to be greatly distended, and terminating at each end at an opening to the left of the lumbar spine. The left margin of the opening contained large blood vessels, which were afterwards seen to be the superior mesenteric, and coils of small intestine were felt and seen to move behind the mesentery. The condition was in fact very suggestive of a right duodenal hernia, only that the distension was in the wrong part of the intestine. The real state of affairs was soon discovered to be due to a prolapse of a part of small intestine forwards through a ring, consisting of a tough, broad band, stretching from the right side of the pelvic brim to the left side of the root of the mesentery, and the displaced mesentery itself, which had been pressed, and rotated to the left by the enormously distended coils in front and to the right. The collapsed small intestines had been displaced with and lay behind the mesentery. The band, which was clearly due to an old appendicitis, was ligatured and severed. The distended intestine, which was the upper part of the jejunum, was severely damaged at the lower point of constriction, and a loop containing this part was therefore brought out and drained. The patient's condition was too grave for a resection to be contemplated, and, moreover, it was hoped that the intestine would recover with drainage. The patient, however, died a week later, due to gangrene of a small loop of the intestine which had been strangulated.

Dr. C. L. Gibson (*Ann. of Surg.*, 1900, vol. xxxii. p. 486), in his classical study of 1,000 cases of intestinal obstruction, found the mortality of 186 recorded cases of bands to be 41 per cent., but the figures are in a sense too favourable for published cases, consist of too many successes and too few failures; in another sense they are too unfavourable, for the figures refer to the ten years between 1888 and 1898, and it is certain that more recent results are more favourable to some extent, although the results of operations for intestinal obstruction have not improved to the extent that they should, because of the want of recognition of the value of emptying and draining the distended intestines, whenever it is probable that nature will not be able to do this quickly without aid.

Meckel's Diverticulum.—This may act as a band over the intestine, and the foetal relic may become twisted at its base. In the case of a diverticular band which is tubular, the contiguous peritonæal contents being all shut off with sponges or tampons, the diverticulum and the intestine into which it opens are emptied by pressure. Then the diverticulum, being lightly clamped, is divided, at its origin the mucous coat is disinfected and tied with silk or closed with a continuous catgut suture, and inverted by means of a continuous Lembert's stitch. When the diverticulum is narrow the simplest and most rapid way is to invert and bury the stump by means of one or two purse-string sutures passing through the sero-muscular coats round the base.

In some cases gangrene of the ileum occurs at the twisted base of the diverticulum, and then a resection, with or without intestinal drainage, will have to be undertaken, unless the area of gangrene is so small that inversion can be performed without risk of narrowing the lumen too much.

A most interesting and fully reported case successfully treated by laparotomy was published in the *Lancet*, March 9, 1889, by my old friend R. J. Pye-Smith, of Sheffield. Two others successfully treated in the same way by Mr. Clutton (*Clin. Soc. Trans.*, vol. xvii. p. 186) and Mr. McGill (*Brit. Med. Journ.*, Jan. 14, 1888) will well repay reference.

Dr. Roberts (*Ann. of Surg.*, vol. ii. 1906, p. 87) records two interesting cases. One patient was a boy of four and a half years, who was treated by operation after four days'

obstruction. A slender diverticulum was discovered about three feet from the ileo-cæcal valve. "Its diameter was less than that of the vermiform appendix. Its end was a mere fibrous cord attached to the abdominal wall near the umbilicus. The structure was distended at its middle into a sac similar to that which is sometimes seen in the appendix when it is inflamed. Between the sac and the ileum there was a patent tube lined with mucous membrane. There was evidence of inflammation of these structures. The ileum, a short distance from the point of origin of the diverticulum, was tightly strangulated by the passage of the diverticulum and its fibrous continuation across it. A deep groove was thus made in the portion of the bowel opposite the mesentery, similar to that often seen in cases of tightly strangulated hernia at the femoral or inguinal ring." The diverticulum and its fibrous prolongation were removed, and the groove on the intestine was inverted by means of Lembert sutures, because it was so dark that sloughing and perforation were feared. The boy recovered after a severe illness.

I operated for acute obstruction due to this cause in a baby of three weeks. The child died, the abdomen being greatly distended and containing a large amount of sanious fluid at the time of the operation. In this case the diverticulum originating within a foot of the ileo-cæcal valve, terminated upon the mesentery of a portion of the ileum, which it passed over and strangulated.

Gibson found the mortality to be 55 per cent. in forty-two operations for intestinal obstruction due to this structure.

B. Apertures and Slits.—These may be congenital or traumatic, the intestine entering and enlarging a congenital retro-peritonæal fossa, or slipping through a rent in the mesentery, omentum or diaphragm.

I. Retro-peritonæal Hernia.—For most of the information upon this subject I am indebted to the valuable, scientific and exhaustive work of Moynihan and Dobson, a new edition of which has just appeared (*Retro-Peritonæal Hernia*, Moynihan and Dobson, 1906).

The chief varieties are—

- (1) The left duodenal, of which over 60 cases have been recorded.
- (2) The right duodenal, of which over 17 cases have been recorded.
- (3) The meso-colic, of which only one certain case has been recorded (Dobson), and possibly that described by Sir Astley Cooper years ago.
- (4) The infra-duodenal, of which Molin has described the solitary recorded instance.

All these arise in the neighbourhood of the termination of the duodenum, the *left duodenal hernia* occurring into the para-duodenal fossa of Landzert, which has the *inferior mesenteric vein in its prominent left, lower, and upper borders*. The *right duodenal* which occurs into the mesenterico-parietal fossa of Waldeyer, which lies in the root of the mesentery of the upper part of the jejunum, and has the *superior mesenteric artery in its prominent anterior border*. The meso-colic hernia is to the left of the inferior mesenteric vein; the infra-duodenal lies below the duodenum, and has no vessels in the prominent edge of its orifice.

The left duodenal hernia enlarges upwards and to the left towards the spleen, its orifice being placed antero-internally in small herniæ, and postero-internally in larger ones.

The right duodenal enlarges downwards and to the right towards the right iliac fossa, its orifice being directed upwards and to the left. Duodenal herniæ nearly always contain only small intestine, but Freeman (*Amer. Journ. Med. Sci.*, Oct. 1903) has recorded a case in which the entire small intestine, the cæcum, and a part of the colon had passed into a left duodenal hernia.

(5) *The pericæcal*, which may be subdivided into the ileo-appendicular, of which 7 cases are recorded; the retro-colic, of which 8 cases are recorded; the hernia into the fossa of Hartmann, which is a fossa placed between the mesentery of the appendix and a continuation of the mesentery of the small intestines to the iliac fossa; one possible case is recorded.

Hernia into the sub-facial or iliac fossa, which is pouch of peritonæum pushed downwards through a weak spot in the iliac fascia, and outside the psoas muscle; two cases of this are recorded, and Mr. Dunn operated upon another one at Guy's Hospital some years ago.

(6) *The intersigmoid*.—Only two genuine cases are recorded, those of Eve, and Macadam Eccles.

(7) The hernia into the lesser sac of the peritonæum, 12 instances of which are recorded.

Diagnosis will generally be arrived at only during a laparotomy for the relief of intestinal obstruction, but in some cases such as that of Sherren, a diagnosis has been made before the operation.

In addition to the classical symptoms and signs of acute intestinal obstruction, other points may suggest or even strongly indicate a retro-peritonæal hernia.

The existence of a duodenal hernia may be indicated by the presence of a "palpable definite resonant mass" at the upper and left part of the abdomen (left duodenal hernia), or at the lower and right part (right duodenal hernia).

This mass does not move on respiration, and coils of intestine may be evident towards the middle of the swelling, the size of which may vary with the severity of the symptoms.

Hæmorrhoids or rectal hæmorrhage may develop in left duodenal hernia from obstruction of the inferior mesenteric vein.

Only one case of pericæcal hernia has been diagnosed before operation, from the presence of a mass in the right iliac fossa, which was rendered more evident by means of rectal injection (Riese).

Hernia through the foramen of Winslow may be indicated by agonising pain in the epigastrium, where a semi-resonant tumour may soon appear.

Treatment.—When the nature of the obstruction has been recognised, attempts should be made to reduce the hernia by a combination of pressure upon the sac and gentle traction upon the intestine. In some cases it may be possible to enlarge the orifice by stretching, in others the prominent margin may be divided, due care being taken to avoid any prominent blood vessels. In left and right duodenal hernia it may not be possible to enlarge the opening without injuring the inferior mesenteric vein in the one case, or the superior mesenteric vessels in the other. Haberer in his successful case divided the inferior mesenteric vein, which he then found to be already thrombosed.

The foramen of Winslow is not capable of enlargement, surrounded as it is by the liver above the vena cava behind, the twist of the hepatic artery below and the portal vein, bile duct and hepatic artery in front. The difficulties that may be met with are illustrated by Sir Frederick Treves' case (*Oper. Surg.*, vol. i. p. 389).

Here the surgeon not only failed to reduce the gut by operation during life, but at the necropsy he could not bring about reduction until the hepatic artery, portal vein, and bile duct were severed.

Incision of the anterior layer of the gastro-hepatic omentum and retraction of the first part of the duodenum with the view of enlarging the opening is considered by Moynihan to be impracticable in cases of obstruction, and I do not believe that it would be any good, for the twist of the hepatic artery would still form the lower boundary of the ring.

Mobilisation of the duodenum by incising the posterior parietal peritonæum to the right of it and detaching it forwards and downwards enlarges the orifice according to Moynihan, but he considers this measure to be almost out of the question in a patient suffering from acute intestinal obstruction.

When the rings cannot be enlarged by stretching, and vessels prevent an incision being made, it is best to open the sac anteriorly and to try to reduce the bowel from within. This may only be practicable after pulling out a loop of distended bowel and emptying it through an incision made along its convex border with all precautions against contamination of the peritonæum. The incision having been closed the reduction will probably be easily performed.

An attempt should be made to close the neck of the sac to prevent a recurrence of the hernia, and the necessity of this is shown by the recurrence in Mr. Paton's case.

It may be neither wise nor necessary to prolong the operation by attempting to close the foramen of Winslow, for a recurrence is not likely here.

Results.—Successful operations for left duodenal hernia have been recorded by Sonnenberg, Tubby, Priestley Leech, Narath, Haberer, Lawford Knaggs, McArthur and Sherren, and one successful operation for right duodenal hernia by Neumann. Four operations for pericæcal hernia have been successful, one of these being the case recorded by Sir William Macewen, who had to resect 8 inches of small intestine for gangrene.

Two successful operations for hernia at the foramen of Winslow have been recorded, but in one of these spontaneous reduction occurred after the surgeon had failed to reduce the hernia during the operation.

II. Traumatic apertures may be formed in the diaphragm, omentum, mesentery or meso-colon, and may result from crushing violence, gunshot and other wounds, or careless operations during which certain openings may not be properly closed. For instance, after gastro-jejunostomy, a hernia may occur through the rent in the meso-colon, and the same thing may follow resection of intestine, unless the mesentery is properly sutured.

The following is an instance of a hernia through a hole in the mesentery.

In Mr. Howard Marsh's case (*Brit. Med. Journ.*, June 2, 1888) a loop, probably in the middle of the jejunum, had slipped through a hole in the mesentery. The edge of this opening was so yielding that Mr. Marsh could readily stretch it with his finger-nail sufficiently to allow the loop to be drawn out. The patient made a good recovery, though in much danger for a while from the paralysed condition of the intestine.

Diaphragmatic hernia occurs far more frequently on the left than on the right of the middle line; thus in 133 instances the rupture was on the left in 100 (Boursier, quoted by Gibson, *loc. infra cit.*).

The hernia may be traumatic or congenital in origin. Dr. Eustace Smith (*Lancet*, May 22, 1904) has lately recorded an instance of the latter. Lickenstern has collected 250 cases of traumatic ruptures, but in only five of these was the condition recognised before death occurred.

Mackenzie and Battle (*Lancet*, vol. ii. 1904, p. 1582) record a very interesting case of hernia which followed a poniard wound in the left anterior axillary line. After a slow recovery the man remained well for about three years, when he was seized with pain in the left side of the upper abdomen and severe vomiting. Several similar attacks followed, and "seven days before admission, when crossing the Channel, he suffered much from sea-sickness and had vomited almost constantly since."

The patient was greatly collapsed on admission into St. Thomas's Hospital, and he was infused. Next day an incision was made parallel to the left costal margin. The small and large intestines were found to be "empty"; the greater part of the stomach, the splenic flexure of the colon and some omentum were found to have passed through an aperture in the muscular part of the left side of the diaphragm; the omentum was adherent and could not be released. The stomach was reduced with great difficulty, but the colon was withdrawn with ease. The patient died after three days from peritonitis, probably arising from the site of the constriction in the stomach.

Battle and Mackenzie state that successful operations have been undertaken for diaphragmatic hernia by Llobet, Humbert Leisrink and Mikulicz. Lawford Knaggs (*Lancet*, vol. ii. 1904, p. 358) has written an elaborate and interesting article upon the subject of hernia of the stomach through the diaphragm, of which he was able to collect 63 cases. Only two operations had been performed in these cases (by Knaggs and Berry), and both these failed to save life. In 23 cases the hernia was congenital in origin, in 21 traumatic, and in 12 acquired; in the acquired cases with sac formation the stomach had protruded through or near the œsophageal opening in the midriff.

Gibson (*Ann. of Surg.*, 1900, vol. xxxii. p. 508) collected the records of six operations for diaphragmatic hernia without a recovery; in several instances the condition was not recognised even during a laparotomy. The splenic flexure, stomach and omentum were commonly found in the ruptures, and the cæcum was present in one. The reduction was not very difficult in those cases in which it was attempted.

Diagnosis.—When the strangulation chiefly concerns the stomach, the symptoms may be very characteristic, but when the obstruction is in the colon, the nature of the lesion may not be discovered until a laparotomy is performed, and it may not be suspected even then.

Sir Samuel Wilks (*Lancet*, 1858, vol. ii. p. 434) drew attention to the existence and importance of excessive thirst in cases of strangulation of the stomach; other suggestive symptoms are urgent vomiting, scanty secretion of urine, carinated abdomen and pain in the epigastrium. In some cases there have been signs of displacement of the heart or left lung, and in others indications of pleural effusion; or hyperresonance of the chest with gurgling noises have been noticed.

When the obstruction concerns the colon, some of these symptoms may be absent, and the abdomen may be markedly distended.

The possibility of the existence of this rare form of hernia should be borne in mind, especially when the cause of the obstruction can not be made out during an exploration.

Treatment.—If the diagnosis of diaphragmatic hernia has been arrived at, a long incision should be made parallel with and one inch below the left costal margin, which should be well retracted. An attempt should be made to withdraw the contents of the hernia without enlarging the aperture, owing to the dangers of hæmorrhage and the difficulties of arresting it at the depth of the wound. The margins of the ring should be closed by sutures of catgut if possible. It is better to approach the hernia from the abdomen than through the chest wall, for sudden death has followed incision of the pleura, and sudden pneumothorax. Llobet has operated successfully through the pleura, however, and after closing the aperture in the diaphragm and the parietal wound he aspirated the air from the pleural cavity. If the abdominal route fail, an incision may be made through the chest wall, parallel with but below the pleural reflection. Three or four inches of two ribs may need resection to give enough room.

II. Intussusception.—From its frequency, especially in early life, its fatality in infants, and the fact that its treatment is less unsatisfactory because its diagnosis is easier than other forms of obstruction, this deserves careful notice.

Diagnosis.—Nowhere is early diagnosis more imperative. This should be based upon the following symptoms :

Sudden abdominal pain followed by shock and *spasmodic attacks of colic*, as indicated by frequent fits of crying; *more or less frequent evacuations of blood and slime with no fecal matter*, except quite early in the case; *vomiting*, and perhaps a sausage-shaped tumour, discovered by abdominal or bimanual palpation. The absence of a palpable tumour is far from conclusive negative evidence, even when the abdominal wall is relaxed under the influence of chloroform, and failure to find one must not be allowed to delay an exploration indicated by more important signs and symptoms. Erdman (*New York Med. Journ.*, May 14, 1904) found that no tumour was palpable in 60 per cent. of his cases, either by the rectum or through the abdominal wall. I think that this experience is unusual, however. Mr. Wallace found a tumour in all of his 20 cases. A dependent lobe of the liver, a mass of mesenteric glands, and a prolapsed spleen have each been mistaken for an intussusception.

Two more points must always be remembered in the diagnosis of intussusception :

- (1) that in cases which are not acute there may be very few symptoms for some time;
- (2) the rectum must always be examined, and any intussusception which may be met with not mistaken for a prolapsus.

The disease should be diagnosed long before the stage of distension and collapse. Careful consideration of all the points mentioned above will usually prevent delay and enable the surgeon to avoid a mistaken diagnosis of enteritis. In cases of grave doubt chloroform should be given.

Treatment.—If a capable surgeon is available, laparotomy should be performed without delay when the diagnosis has been made, for an early operation quickly performed is the only reliable and hopeful treatment. In very early cases reduction may be possible with comparatively little force, and may be brought about satisfactorily by injection or inflation, but the results of this treatment are so

unsatisfactory and deceptive that no reliance must be placed on it, unless suitable surgical aid cannot be obtained without delay. Very soon, however, the engorgement of the intussusceptum and the included mesentery, or the adhesion of the entering and returning layers as the result of peritonitis, renders reduction much more difficult or impossible. In such cases distension of the colon will either fail altogether, or will produce only partial reduction, with subsequent speedy relapse. The following figures from Gibson's list (*loc. supra cit.*) will serve to emphasise this important point: 94 per cent. of the cases treated within the first twenty-four hours were reducible on abdominal section, whereas only 61 per cent. of those treated on the third day were reducible. The proportion reducible by *distension* would necessarily have been less than the above in each case.

The following results of distension will also serve to emphasise the importance of not wasting time in attempting to reduce an intussusception by injection or inflation. Mr. Eve collected 24 cases from the records of the London Hospital in which distension was tried. Of these six died without further treatment, and the remaining 18 required operation. Mr. Barker (*Clin. Soc. Trans.*, vol. xxxi.) tried distension in eight cases, in all of which it failed; and in a collection of cases by Wiggins distension failed in 75 per cent. of 72 cases in which it was tried.

Moreover, the following *objections* to distension must not be lost sight of:—(1) The danger of sudden collapse or rupture of the bowel; (2) the loss of valuable time, rendering the result of a laparotomy less likely to be successful; (3) it will be of no use in enteric intussusceptions (which form 22 per cent. of all cases), and probably of no use in ileo-colic intussusceptions (which form 12 per cent.), so that in 34 per cent., or in one case in every three, it is practically certain to fail; (4) there is no certain means of telling at once that the injection has been successful; the disappearance of the tumour, if any, is not reliable, for the proximal first few inches may not be palpable; the bowels may not be opened for a day or more after a satisfactory reduction.

At St. Thomas's Hospital between 1892 and 1901 the mortality in 62 patients under one year of age was 38, or 62·29 per cent., but in the last three of those years, when cœliotomy became primary as a routine measure, the mortality was only 47·5 per cent.

In cases of less than twenty-four hours' duration, distension of the bowel is still used by some surgeons as an auxiliary, but not as a substitute for laparotomy. Mr. Kellock has recommended this method as a means of reducing the greater part of the invagination just before the abdomen is opened. The manipulations and exposure of the intestine and the duration of the operation may be thus lessened. I consider these advantages to be uncertain, and to be more than balanced by the increased abdominal distension and the prolongation of the anæsthetic—a grave thing in these cases. Moreover, the finger of an assistant or a bougie in the rectum give all the aid that may be required to displace the invagination out of the pelvis.*

Personally, I never attempt to distend the intestine, even as a

* C. H. Fagge, *Clin. Soc. Trans.*, vol. xxxviii,

preliminary, but proceed to operate as soon as the necessary preparations can be made.

Either water or air may be used for injection ; of these the latter is to be preferred, as being less dangerous.

The child's limbs are wrapped in cotton wool or gamgee tissue, and his body is exposed as little as possible.

A little chloroform or A.C.E. mixture being given, the lower limbs being somewhat raised, the nozzle of a Lund's inflator, or a full-sized catheter, or a rectal tube, attached by tubing to a bellows and well coated with vaseline, is carefully passed into the bowel. The nates being securely pressed round the tube, air is steadily pumped into the colon,

FIG. 82.

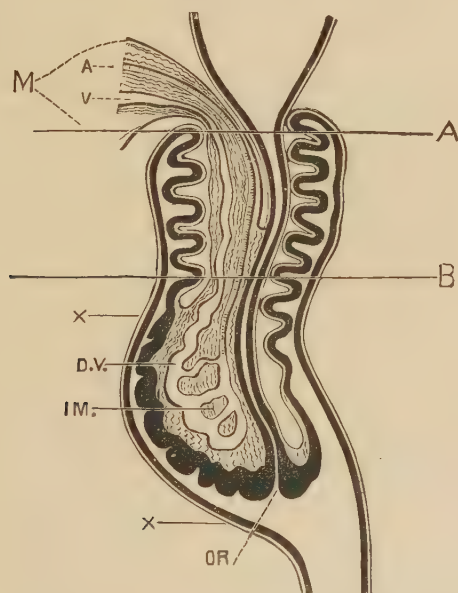


Diagram of an intussusception in vertical section.

M, Mesentery. A, Artery. V, Vein. D.V. Dilated vein. I.M. inflamed mesentery. OR, Orifice of bowel at apex of intussusceptum with thickened mucous membrane around. A, Line drawn through usual seat of adhesions. B, Line for resection of intussusceptum. X X, To mark the vertical incision through which resection is performed. (Greig Smith.)

while the surgeon keeps one hand on the abdomen, not only to prevent over-distension, but also to watch for any receding of the tumour towards the cæcal region. Great care must be taken not to use too much force, especially towards the end of the process.

Dr. Taylor's advice here will minimise the risk of rupture of the bowel: "The risk can be reduced to a minimum by injecting, carefully and slowly, successive small quantities, and by gently kneading the abdomen so as to facilitate the passage of air upwards, and thus prevent the sudden over-distension of short lengths of the colon."

Operation.—This should be conducted with as much speed as is consistent with safety, and the child should be exposed as little as possible; therefore all preparations should be completed before the chloroform is administered. Plenty of sutures should be threaded ready for immediate use, for every moment of time saved is of value,

and the prognosis varies inversely with the length of time that the patient is upon the operating table. All aseptic towels used should be dry and warm, so that the child may not be chilled by evaporation; the table should, of course, be warm. During the preparations the abdomen should be cleansed and covered with a warm antiseptic compress.

The urine having been drawn off, an incision about three inches long is made over the right rectus muscle; the centre of the wound should be about three-quarters of an inch below and to the right of the umbilicus (Wallace, *loc. infra cit.*).

This incision gives better access to the seat of origin of the great majority of intussusceptions in children, for they nearly all start near the cæcum, to whatever variety ingenious classification may refer them.*

The reduction of the most difficult part can thus be performed within sight—a very important thing.

The antero-rectus sheath is incised, and one edge of it is rapidly raised from the muscle to facilitate overlapping later on. The muscle fibres are separated by blunt dissection to avoid delay from hæmorrhage, if possible.

The posterior layer of the rectus sheath and the attached peritonæum are incised to the extent of two inches, and an attempt then made to discover the intussusception and to hook it into the wound by means of one or two fingers. In most cases this is not possible, for the mass is usually tethered back to the spine by the invaginated mesentery. In these cases the peritonæal incision must be enlarged, and then most of the reduction can be easily and safely performed within the abdomen by manual compression of the distal part of the tumour, which also may be pushed towards the proximal end.

In some cases I have been able to reduce the greater part of the invagination by bimanual compression, the intussusception being squeezed between the fingers of the right hand within and the left hand outside the abdomen. Care must be taken to prevent the escape of coils of small intestine.†

Early and small invaginations may be brought into the wound at once, and towards the end all reductions can and should be performed with the aid of sight; otherwise serious damage may be done to the bowel. This part of the reduction must

* E. M. Corner (*Ann. of Surg.*, November, 1903) concludes that double intussusceptions are more common than single, but the experience of other observers does not confirm this view. I agree with him that the ileo-colic is the commonest primary variety, the last part of the ileum becoming gripped in the ileo-cæcal valve. He considers that the primary ileo-cæcal variety is decidedly rare, and almost limited to chronic cases, the recorded cases probably starting in the last few inches of the colon or the cæcum.

† Mr. Wallace (*Clin. Soc. Trans.*, vol. xxxviii. p. 59) makes no attempt to retain the intestines in the abdomen, and if they escape he simply covers them with warm sponges. Mr. Wallace's results are very good, but all the surgeons who have to do this operation are not so skilful and expeditious as he is, and I have no doubt whatever that to allow the intestines to protrude is a mistake, for it may be very difficult to replace them, and much valuable time may be thus wasted. Moreover, shock is greatly increased by the exposure, traction on the mesenteric plexuses, and the manipulations necessary for reduction.

be conducted with care, and traction on the entering intestine must not be made, except with the utmost gentleness; the ensheathing layer should be fixed below the presenting point, and then it will usually be found that pushing or backing out the contained bowel by gentle squeezing movements between the finger and thumb, these being gradually shifted along the gut, will prove successful, when by no force that is justifiable could any part be drawn out.

Whichever method is found to answer best must be persevered with until every atom of the mass is reduced, this being often known by the appearance of the vermiform appendix.

If, when the reduction is complete, any tears are noticed in the peritonæal coat, these must be sewn up with a fine continuous silk suture, and any thin or grey lines should be inverted by Lembert sutures to prevent perforation or infection, and to avoid the need of enterectomy in some cases.

The wound should be rapidly closed by means of fishing-gut sutures, which pierce the whole thickness of the abdominal wall, and before these are tied the anterior wall of the rectus sheath may be closed in an overlapping manner by means of a continuous catgut suture to lessen the risk of ventral hernia. When the wound is sewn up in layers without the aid of sutures, which pierce the whole thickness of the parietes to relieve tension, there is some risk that the wound may reopen, allowing the intestines to escape. This happened to two of three cases in which Mr. Wallace relied upon three layers of sutures (*loc. cit.*). The sutures may tear out the delicate and thin layers of an infant during the stage of inflammatory softening that precedes firm union, which is slow to occur in these cases.

A warm saline enema may be given immediately after the patient has returned to bed, and every effort must be made to prevent and combat shock both during and after the operation; saline infusions into the cellular tissues of the axilla and the subcutaneous injection of strychnine should be given in bad cases. *Liquor strychninæ hydrochloratis* m *iii.* may be given, and repeated, if necessary, every two hours, as long as twitching does not occur. Adrenalin chloride and aseptic ergot are preferable to strychnine.

Feeding with peptonised milk and albumen water should be commenced as soon as possible after the operation, as long as vomiting does not occur, for starvation is one of the serious factors in the cases.

When the intussusception cannot be reduced, all attempts at traction and kneading only causing tears in the peritonæal coat, the following courses are open according to the condition of the patient, &c.:—(1) If the intussusception is gangrenous but small in amount, it should be resected. For the union of the divided ends Murphy's button has the great advantage of saving time, and it is thus well adapted to acute and subacute cases in children, which form the majority of the cases; but most surgeons now prefer to use sutures only. Whatever method is used, some difficulty must be expected in effecting exact union in the common variety, the ileo-cæcal, owing to the difference of the lumen in the two parts of the bowel; where this difficulty is very marked, the best plan will be to close both ends by a double row of sutures, continuous and Lembert's, and then to make a lateral anastomosis (*q.v.*) by means of direct suture or Murphy's

button, &c. (2) If the invagination is irreducible but not gangrenous, it may be left, and the continuity of the canal restored by short-circuiting the small and large intestine above and below the invagination by Murphy's button or some other means. (3) Where the patient's condition is good, as in chronic cases, an irreducible intussusception is best treated by an operation based by Mr. Jessett (*Surg. Dis. of Stomach and Intestines*, p. 140) on what is known as spontaneous cure. It was three times performed successfully on dogs. An invagination having been made artificially, and found a week later firmly adherent, it was thus removed. A longitudinal opening was made into the intestine over the root of the intussusception on the side

FIG. 83.

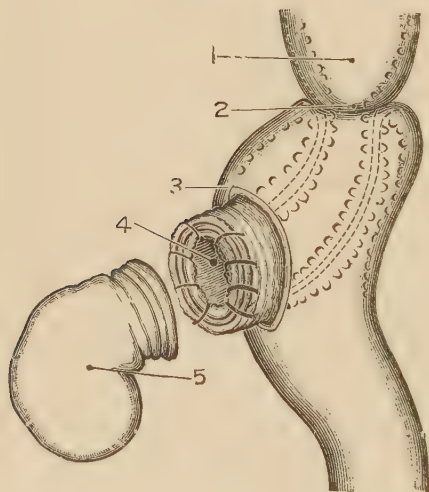


Diagram showing removal of apex of intussusceptum through an incision in the intussusciens.

1, Entering bowel. 2, Neck of intussusciens. 3, Incision in intussusciens. 4, Cut edges united by sutures. 5, Apex of intussusceptum excised. (Greig Smith.)

FIG. 84.



Operation of resection of intussusceptum completed. (Greig Smith.)

farthest from the mesentery, about an inch and a half long, of sufficient length to allow the invaginated part to be drawn out with vulsellum forceps. The root of the invaginated part having been pulled out through the above opening, was cut through close to its origin, any vessel which required it being tied. Then the divided coats where the intussusception had been cut away were united with a few points of suture, the lumen of the bowel being left open. The stump was then returned into the intestine, and the incision in this closed by quilt sutures. Greig Smith (*Abdom. Surg.*, p. 676) recommended this method of treatment, but modified the operation in cases of extensive invagination in that, as will be seen by reference to Figs. 83 and 84, he removed only the apex of the intussusceptum, this being the most swollen part, and therefore the chief obstacle to reduction. The rest was then gently reduced. Although reduction will be rendered possible

in some cases by removal of the apex of the intussusceptum, in others the adhesion of the layers at the neck of the intussusception to one another will make reduction impossible. In such cases, a more complete resection of the intussusceptum will be necessary. Israel (*Med. Record*, May 20, 1905) advocates a modification of the method just described: he first fixes the intussusception to the parietal peritonæum, and then resects the invagination through a longitudinal incision, which is now extra-peritonæal; the incision in the bowel is left open for a few days for drainage. Israel has had two successful cases with this operation. Other and less desirable methods which may be thrust on the surgeon, owing to the circumstances under which he operates, are: (4) Resection and formation of an artificial anus.* (5) Formation of an artificial anus without resection, which is not recommended under any circumstances, for the primary mortality is as great as that of resection, and the mortality of secondary resections is high (about 50 per cent., Gibson) in these cases. Finally, in those rare cases of invagination of the colon into the rectum, the intussusception may be drawn down and removed by the operations of Mikulicz or Mr. Barker in this country. The latter surgeon's cases will be found in the *Med.-Chir. Trans.*, 1887, vol. lxx. p. 335, and *Brit. Med. Journ.*, vol. ii. 1892, p. 1226. In both cases a malignant growth was at the root of the invagination, and in each operation steps were facilitated by the ease with which the growth, after dilatation of the anus, could be pulled outside. Two rows of sutures were made to encircle the bowel, and to unite the two layers of the intussusception firmly together well above the new growth. As the sutures were passed, care was taken that no small intestines protruded. Both cases recovered, and the first was alive four or five years after the operation.

Mortality.—In considering this, it must be remembered that every recovery means a life saved from almost certain death. Earlier diagnosis and above all earlier resort to primary operation have greatly improved the prognosis. Wallace (*Clin. Soc. Trans.*, vol. xxxviii.) records 20 consecutive cases with only four deaths, a mortality of only 20 per cent., or excluding the cases severe and late enough to require resection, 11·11 per cent. The average duration of the operation in 11 cases was fourteen minutes, and this list included one of resection, and also one of excision of a gangrenous appendix.

Fagge reports 18 cases with six deaths, a mortality of 39 per cent., but he was unfortunate in meeting an unusual number of gangrenous cases, and if these late cases be excluded the mortality is only 15·4 per cent.

Clubbe (*British Med. Journ.*, Jan. 17, 1905) gives an account of 100 consecutive laparotomies for intussusception. Of the first fifty, twenty-five died, whereas of the last fifty only twelve died, owing to the children being sent into the hospital earlier, and to improvements in treatment.

F. C. Wallis (*Lancet*, vol. i. 1904, p. 1648) relates four cases without a death. The average duration of the operation was eleven minutes.

Rigby records seven cases (*Lancet*, Jan. 14, 1902), one of which was

* Prof. Senn quotes a case of Wassiljew's (*Centr. f. Chir.*, 1888, No. 12), in which an operation was performed to close the artificial anus six months later. It was ultimately successful.

too late for operation, and one needed resection ; the other five recovered. In none of the cases did the operation last more than fifteen minutes.

G. Owen (*Intercolonial Med. Journ. of Australasia*, Oct. 20, 1902) records a case in which a recurrence occurred within twenty-four hours of the operation ; the second operation did not save the child.

Cole (*idem*, August, November, and December, 1904) mentions a case in which a second operation proved successful.

Erdman (*New York Med. Journ.*, May 14, 1904) removed the appendix in all his 11 cases, because it formed a part of the intussusception.

This is not to be recommended unless the appendix is dangerously damaged, for the delay may be serious. Keetley recommends an appendicostomy as a means of drainage, feeding, and prevention of recurrence. In some cases of great distension this may be wisely done.

Recovery after resection of a gangrenous intussusception is a very rare event. Thus Gibson* in his collection of 1,000 cases of intestinal obstruction found only one case of recovery after resection for this condition. In an earlier collection in 1897 there were 239 cases of intussusception, with no recovery from irreducible intussusception in a patient under seven years of age, and only nine in older people.

W. H. Brown (*Lancet*, Sept. 16, 1905) records a remarkable case of an enteric irreducible intussusception caused by a worm. Resection was resorted to, and Paul's tubes tied in. After four attempts the artificial anus was closed, and the patient recovered.

Dowd (*Ann. of Surg.*, vol. xxxvi. 1902, p. 48) records a recovery after resection in a gangrenous subacute invagination in a boy of 4½ years, and Skevington (*Lancet*, 1905, vol. xi. p. 890) relates a successful resection for gangrene in a boy of 12.

The hope of the future lies not in successful resection, but in less frequent need of that operation, which must always carry a very high mortality with it in these cases. In chronic or subacute cases in older patients recovery is not so rare.

Mr. F. C. Wallis (*Lancet*, Dec. 5, 1903) records an interesting case of irreducible chronic intussusception of the small intestine, occurring in a woman. Mr. Wallis resected forty-two inches of the bowel, and joined the ends by means of a Murphy's button, which he had to remove from the ileum about three and a half weeks later. The button used was too large, and therefore gave rise to symptoms of obstruction, but the patient recovered.

Mr. Watson Cheyne records a successful case of resection of a chronic intussusception which was due to invagination of Meekel's diverticulum, and he refers to another case (*Ann. of Surg.*, vol. xl. 1904, p. 796).

Zum Busch (*Clin. Soc. Trans.*, vol. xxxvi. p. 213) records a successful resection in a similar case in a young man, and he mentions a case of Hirschsprung in which spontaneous recovery occurred.

III. Volvulus.—The intestine here is usually either twisted on its mesenteric axis, or bent at an angle. The first is the acuter condition, owing to the strangulation of vessels. It is usually met with in the sigmoid flexure, when this has a long mesocolon, especially in adults who have been subject to constipation (Treves). The distension may be enormous, the sigmoid appearing to occupy the whole abdomen.

* *Ann. of Surg.*, October, 1900, p. 497.

Ulceration leading to fatal peritonitis may set in either in the sigmoid, the colon, or the cæcum.

Mr. Makins (*Lancet*, vol. i. 1904, p. 156) believes that volvulus of the cæcum is far commoner than is generally considered, and he records a typical and interesting case:—

The patient was a woman, 67 years of age. During the last eighteen months she had been the subject of four or five distinct attacks of abdominal pain, accompanied by vomiting sufficiently severe to confine her to bed. Ten days prior to her admission to hospital she was seized with severe pain in the lower abdomen, most acute in the region of the umbilicus. Obstruction of the bowels had been complete for six days, vomiting had been frequent, and neither flatus nor fæces had been passed per rectum. On admission the woman looked anxious and ill; vomiting of dark fæculent smelling fluid was frequent. Constipation was absolute. Her tongue was furred but not very dry. Her pulse-rate was 108, and her temperature was 97° F. Her abdomen was considerably distended; the prominence was median, and on inspection gave the impression of a tumour rising from the pelvis. It was resonant throughout except in the right flank.

An operation having been decided upon, the abdomen was opened through the right rectus from just above the level of the umbilicus downwards. A hugely ballooned piece of bowel was at once disclosed, occupying the whole field of operation. The incision was enlarged, but the distended gut could not be delivered, as it was tightly wedged into the pelvis. A trocar and cannula were therefore introduced, and a large quantity of gas and liquid fæces was evacuated. The slackening of the tumour thus produced allowed of the hand being inserted into the pelvis beneath the sac, and the piece of bowel was brought out. The intestine affected proved to be the cæcum and lower part of the ascending colon, which was provided with an unusually long mesentery. The twist was through half a circle, and involved the ascending colon about the centre of its length. The ileum remained viable. It was considered advisable completely to empty the loaded bowel, which was then readily replaced, the two punctures having been securely sutured. The patient made an uneventful recovery, the bowels acted spontaneously the day after the operation, and the stitches were removed from the abdominal wound on the eighth day. On the fourteenth day a localised collection of pus was evacuated from the lower part of the wound in the abdominal wall, and at the end of a month the patient left the hospital recovered.

Corner and Sargent (*Ann. of Surg.*, 1905, vol. xli. p. 63) have since collected and analysed 57 cases, including their own. They lay stress on the fact that all the cases are not acute, but that chronic and sub-acute varieties exist. Before the final complete obstruction, many of the patients suffer from constipation, paroxysms of pain in the right iliac fossa, which may be mistaken for appendicular colic, because fever is absent. In some cases there is a history of a previous and milder attack of intestinal obstruction. The cæcum and the ascending colon may be unduly loose, and the mesentery of the ileum unduly long, with narrow attachment. Rotation may occur upon the root of the mesentery and the superior mesenteric artery, or upon the lower part of the mesenteric attachment, or upon the vertical axis of the cæcum and colon.

In the majority of cases the distended cæcum travels upwards and to the left behind the root of the mesentery, and may be found near the spleen; in others it may lie in the lumbar region, or fall into the true pelvis.

Hilton Fagge in his classical paper on intestinal obstruction described two interesting subacute or chronic cases many years ago (*Guy's Hospital Reports*, vol. xiv.).

In recent years, many surgeons have discovered this condition during an exploration for acute or subacute obstruction. It is curious that Mr. A. E. Barker states that he has not seen a case (*Lancet*, vol. i. 1906, p. 599). Sherren, Jonathan Hutchinson, Spencer, and others mentioned cases (*loc. supra cit.*). It is three times more common in males than females.

The following points are noteworthy in the diagnosis and treatment of volvulus. It is not uncommon for this form of obstruction to follow an injury,* some loop of bowel distended with fæces, and with a long mesentery probably becoming suddenly displaced and unable to recover itself. Again, this form of obstruction has been noticed, whether as a mere coincidence or not, in many cases in the insane. Finally, at the time of treatment, Sir F. Treves's warning (*Oper. Surg.*, vol. ii. p. 390) must always be remembered: "The reduction of a volvulus does not usually remove the anatomical condition that led to it." The truth of this is shown by their tendency to recur.

Thus the late Mr. Greig Smith (*Abdom. Surg.*, p. 450) described a case of volvulus of the small intestine which recurred a week after it had been untwisted by abdominal section. Enterotomy was then performed, and the patient for some time wore a catheter in the opening to allow of the passage of flatus into a bottle which he carried in his pocket. After some time the distended bowel had so contracted that the use of the catheter could be dispensed with. Dr. Finney reports (*Johns Hopkins Hosp. Bull.*, March, 1893) a case of volvulus which involved the whole colon between the ileo-cæcal valve and the sigmoid; it was rectified by operation, and recurred nearly three years later. A second recovery followed.

Whiting (*Ann. of Surg.*, vol. xxxix. p. 1036) relates two cases of volvulus of the whole of the jejunum and ileum. One of the patients, a boy of five, was moribund at the time of the operation; the other, a man of 34, recovered.

Tully Vaughan (*Journ. Am. Med. Assoc.*, May, 1903) has collected 21 cases of volvulus of the small intestines; seven of these were submitted to operation, and 14 recovered. In several cases, the difficulties were so great and the appearances so puzzling, that the operators did not recognise the condition during the operation.

J. B. Roberts (*Ann. of Surg.*, 1906, vol. xi. p. 242) records a case of volvulus of a part of the ileum complicating typhoid fever; the patient recovered. He also refers to two other cases, in which the lesion was only discovered at the autopsy (Eustis). In another case, volvulus followed coeliotomy for a perforated typhoid ulcer; the patient recovered from the two operations.

* See cases mentioned by Mr. Turner, Dr. F. Hawkins, and Mr. Stavely (*Lancet*, vol. ii. 1892, p. 995); a case successfully operated on by Mr. Silcock (*Clin. Soc. Trans.*, vol. xxviii. p. 180). References are made in the latter paper to eight successful cases operated on abroad.

F. T. Stewart (*Journ. Amer. Med. Assoc.*, March 19, 1904) records one case and presents an analysis of eight other cases of volvulus of the great omentum, but in none of these was intestinal obstruction diagnosed. In five of them the omentum was connected with a hernia, and a diagnosis of strangulated hernia was arrived at in two of these. Four of the patients were thought to be suffering from appendicitis.

I know of one fatal case in which a volvulus of the sigmoid followed and was probably due to an operation for the relief of hæmorrhage from a left tubal fœtation.

Treatment.—A free incision will be required here, so as to enable the surgeon to get at the root of the volvulus. The volvulus may present at once as a hugely distended coil; it may be felt as a localised collection of intestine; if twisted, the twist may feel like a band, and a band may actually complicate the case, as when a vermiform appendix is coiled round the root of the twist of the volvulus (*Brit. Med. Journ.*, vol. ii. 1892, p. 170). If attempts at reduction fail, the volvulus should be emptied by carefully inserting a temporary enterostomy tube near the summit of the loop brought outside the abdomen if possible and surrounded with gauze packing. If a proper enterostomy tube be not available, a long and curved trocar and cannula may be inserted within an area which is surrounded by a purse-string suture, which can be tied as the cannula is withdrawn. The perforation made to introduce an enterostomy tube can be closed in the same way or by the introduction of several Lembert sutures. When the loop has been emptied as far as possible, further attempts at reduction should be made, and they will generally succeed. The coil should be fixed to the parietes to prevent recurrence of the trouble. This is best done by suturing the loop and its mesentery to the postero-lateral wall of the abdomen. Care must be taken not to insert sutures near the course of the ureter or the iliac vessels or other structures of importance on the posterior wall. No potential hernial cavity or orifice must be made by leaving a gap or fossa between the loop and the parietal peritonæum. Shortening of the mesocolon, as advocated by Prof. Senn, is not to be recommended, for gangrene of the loop may follow this proceeding.

Mr. Maunsell's method of fixing the reduced cæcum by performing appendicostomy has much to recommend it, for not only is the cæcum drained of its poisonous products for as long as may be thought desirable, but the fistula can be closed practically without risk at any time (*vide* p. 146). Plication of the cæcum has been adopted to lessen the size of the viscus and prevent recurrence (Corner and Sargent, *loc. cit.*); but judging by the temporary nature of the results of gastroplication, this does not seem to be a very reliable way of preventing recurrence.

In some cases, small gangrenous areas or grey thin lines may be seen; and these may be inverted, as recommended by Makins (*Clin. Soc. Trans.*, vol. xxxvi. p. 183). If the condition of the bowel be too bad for the safe adoption of this treatment, the damaged loop should be resected as rapidly as may be, and after the contents of the bowel above the obstruction have been evacuated end to end anastomosis should be performed by direct suture. Tying in Paul's tubes in the ileum, and lower end of the ascending colon, in cæcal cases, is not recommended, for anastomosis does not take much more time, and it is far more satisfactory both immediately and remotely.

If the volvulus be merely irreducible, a temporary artificial anus may be made above the twisted loop, which has been first completely emptied and securely closed. Although this plan may be successful in some cases, it should not be resorted to until every reasonable effort has been made to untwist the coil, and in patients who are *in extremis*. In some cases, where the volvulus is persistent, recurrent, or irreducible, or where a fæcal fistula persists, excision of the twisted loop is the best treatment.

Lateral anastomosis of the extremities of the loop, as advised by Braun, is not to be recommended, for the base of attachment of the loop of bowel becomes too small. Anastomosis between the ileum and the descending loop of the sigmoid may be of service in some rare and irreducible cases.

Mr. Sherren (*Lancet*, vol. i. 1906, p. 599) has recorded a brilliantly successful resection of a gangrenous volvulus of the cæcum, followed by immediate and direct end to end anastomosis of the ileum and ascending colon. Mr. Arbuthnot Lane has successfully resected an enormously distended gangrenous volvulus of the sigmoid flexure.

The mortality of volvulus is very high. Thus in Corner and Sargent's collection of 57 cases 19 recovered and 21 died after operation; the remainder died without operation. This gives a mortality of 52·5 per cent. for the operation, but it should be pointed out that these statistics range over a good many years, and that future results may be expected to be better. Earlier recognition and earlier exploration in all cases of reasonable doubt will do much towards attaining this end. But of the six cases that formed the basis of Corner and Sargent's paper only one recovered, although five at least of the operations were performed since 1902. Evacuation of the distended loop and of the intestines above the obstruction are also important elements in the success of the operation.

IV. Gallstones, Intestinal Calculi, &c.—Gallstones, the most common of these, present cases very favourable for operation if taken in time, owing to the simplicity of the cause of obstruction, and the facility with which it may be usually dealt with. Operation has been here too often deferred, owing to the fact that these patients, usually advanced in life and stout, are not well suited to operation from a general point of view, and because it has been strongly insisted upon by some that if pain and spasm can only be removed, the local cause of the obstruction will pass on. This I believe to be a mistake. Sir F. Treves (*Intest. Obstruct.*, p. 335) states that of 20 cases in which gallstones "produced definite and severe symptoms of obstruction" six patients recovered by the spontaneous passage of the stone, and 14 died unrelieved. It is to be hoped that the successful cases which have been published, one as long ago as 1887 (*Lancet*, Dec. 3), by Mr. T. Smith, Mr. Clutton (*Clin. Soc. Trans.*, vol. xxi. 1888, p. 99), and more lately by Mr. A. Lane (*ibid.* ii. 1894, p. 382) and Mr. Eyc (*Clin. Soc. Trans.*, vol. xxv. 1895, p. 91),* Mr. Barnard (*Ann. of Surg.*, vol. xxxvi. 1902, p. 160), Mr. Paul (*Liverpool Med.-Chir. Trans.*, June, 1904), may bear good fruit. In some cases, in addition

* In this paper some 30 cases which have been treated by abdominal section are given and the result considered.

to the age, stoutness, and habits of the patient, the history of previous inflammation in the neighbourhood of the gall-bladder may help the diagnosis. In four cases, certainly, the calculus has been felt—the abdomen being undistended—before operation. But in the majority it is probable that here, as elsewhere, operation alone will demonstrate the cause of the obstruction.

The following courses may be adopted: (1) To try and pass on the stone through the ileo-cæcal valve into the large intestine. Mr. Clutton (*Clin. Soc. Trans.*, vol. xxi. p. 99) succeeded in doing this, the stone being situated eight inches above the valve. But usually the stone is too firmly fixed.

Mr. Clutton's case is a very instructive one. The patient, a woman aged 70, was operated upon within twenty-four hours of the beginning of the attack. Fifteen months before she had passed a large faceted biliary calculus, and after her recovery from this had had a swelling in the region of the gall-bladder. This disappeared with the onset of the obstruction. A median incision four inches long having been made, the stone was readily felt, and though it tightly fitted the lumen of the intestine, it could be forced along. As, owing to the early date at which the operation was performed, there was no marked difference between the intestine above and below the obstruction, the site of the ileo-cæcal valve was determined by making out the cæcum and the appendix. There was not much difficulty in urging the calculus in the right direction, but as soon as the valve was reached some considerable force was required to make it pass through. This most successful case strongly supports Mr. Clutton's advocacy of an early operation, before the stone has become so immovable as to require opening of the intestine.

If the stone cannot be pushed onwards, and if it is too hard to be broken up by gentle pressure with the finger, it must be removed. The loop of bowel containing the calculus is drawn well outside the abdominal cavity, and the stone is displaced upwards into more healthy intestine if possible. An assistant fixes the stone by compressing the bowel above and below it, while the surgeon removes the stone through a longitudinal incision made along the free border of the intestine. Care is taken not to lacerate or bruise the edges of the wound by trying to extract the stone through an incision which is too small. If the intestine above the obstruction is distended, its toxic contents must be evacuated through the incision, care being taken to hold the latter over a basin well away from abdomen. The intestine is then thoroughly cleansed, and the incision closed carefully with Lembert's or Halstead's sutures.

If the bowel at or just above the stone be gangrenous, it should be resected, and end to end anastomosis performed immediately after emptying the distended intestine above. If the condition be doubtful, any small grey area may be inverted, and the intestine returned just within the abdomen, or, better, the loop may be resected. In some grave cases an enterostomy tube of comparatively small calibre may be temporarily tied in, the opening being inverted after two or three days.

Immediate resection is far preferable to the formation of an artificial anus if the condition of the patient is good enough to allow this.

Mr. S. M. Smith (*Lancet*, vol. ii. 1905, p. 1174) relates a fatal case of obstruction of the sigmoid flexure by a gallstone which had entered the transverse colon from the gall-bladder; the stone was not discovered at the operation.

Mr. Milward records a similar case, in which he successfully removed a large stone from the sigmoid (*loc. cit.*, p. 1327).

Dr. Le Conte (*Ann. of Surg.*, 1902, vol. xxxvi. p. 300) had to resect a piece of gangrenous small intestine above the stone, which had been forced along by purgatives after it had caused injury and infection of the bowel and its mesentery at the site of its original impaction. End to end anastomosis was performed at once, but the patient died.

Prognosis.—From the deceptive nature of the symptoms and often from the incompleteness of the obstruction, delay in exploring is far too common, and the septic contents of the obstructed bowel are often not removed. It is not surprising therefore that the operation is attended by a high mortality. In Barnard's eight cases (*Ann. of Surg.*, vol. xxxvi. 1902, p. 161) the mortality was 57 per cent., in Courvoisier's 125 cases it was 44 per cent., and of Schneller's 82 cases 56 per cent. died. In Eve's 20 collected cases the mortality was 40 per cent.

Embolism; Thrombosis of the Mesenteric Vessels or of the Abdominal Aorta.—Mention must be made of the above conditions, as it is clear, from the cases published, that, though rare, they may simulate acute intestinal obstruction very closely. The explanation appears to be that a loop of intestine, deprived of its blood supply by an embolus, will functionally be as completely paralysed as if it had been strangled. Instructive cases of this kind will be found published by Mr. M'Carthy (*Lancet*, vol. i. 1890, p. 646) and Dr. Munro, of Middlesborough (*ibid.*, vol. i. 1894, p. 147).

Dr. Munro quotes from Gerhardt and Kussmaul the following diagnostic points of these cases: (1) A source of origin for the embolus; (2) profuse hæmorrhage from the bowels; (3) severe colic-like pains in the abdomen; (4) rapid reduction of temperature; (5) demonstration of an embolus in some of the other arteries; (6) palpation of infarct in the mesenteries. In Dr. Munro's case, one of these, situated in the mesosigmoid, could be felt, before operation, in the left iliac fossa. To these points might be added advanced age and no evidence of malignant disease. The mischief is usually too extensive to admit of surgical interference. If it be limited to the small intestine, several branches are usually plugged.

The recorded cases have almost always ended fatally. In several cases, however, the portions of bowel and mesentery involved were removed with success.

Tyson and Linington (*Clin. Soc. Trans.*, vol. xxxv. p. 114) report a case of resection of about a foot of gangrenous small intestine, the condition being due to atheromatous embolism of a branch of the superior mesenteric artery in a woman 66 years of age. Considerable difficulty was experienced in getting the stitches to hold in the sodden and friable mesentery, and the patient died.

Jackson, Porter, and Quinby (*Journ. Amer. Med. Assoc.*, June 4, July, 1904), have collected and analysed 214 cases of embolism and thrombosis of the mesenteric vessels.

They found that blood was passed per anum in only 41 per cent. of the cases. In 47 cases operations had been performed, with four recoveries, or a mortality of 92 per cent.

A review of the pathological appearances indicated that in about 15 of the cases which had not been submitted to operation short resections might have been performed with advantage.

Elliot (*Ann. of Surg.*, 1905, vol. xlii. p. 674) describes an interesting

case of thrombosis of a part of the superior mesenteric vein leading to gangrene of a loop of jejunum fourteen inches long; this was successfully resected. The thrombosis came on eighteen days after anterior gastro-jejunostomy.

APPENDICITIS.*

Before discussing the question of surgical interference here, it will be well to make plain what we mean when speaking later of the **varieties** of this disease. These are—

i. *Catarrhal and Early Interstitial Appendicitis*.—Here the inflammation is limited to the mucous membrane and the other coats of the appendix, but goes no farther (if the attacks be slight) than at the most a little plastic peritonitis and a few slight adhesions.

ii. *Appendicitis with a Localised Abscess*.

iii. *Acute Perforating and Gangrenous Appendicitis*.—Of these two, the first may at any time lead to a general peritonitis; the second, if left, often does so.

iv. *Relapsing or Recurrent Appendicitis*.

Question of Operative Interference in Acute Appendicitis.

WHEN TO OPERATE AND WHEN TO WAIT: TWO CAMPS OF OPINION.

One of us has already said, in a lecture elsewhere (W. H. A. Jacobson, *Polyclinic*, December, 1900), much of what follows concerning the present state of opinion on this subject; but some more recent statistics and comments have been added.

“(a) *Advocates of Waiting and Watching*.

“Those who follow on these lines rely on the fact that the majority of cases of appendicitis recover under medical treatment. In other words, they represent that the dangerous forms in which sloughing or gangrene or perforation of the appendix with suppurative peritonitis, pylephlebitis, &c., follow, are but few. Dr. Hawkins, quite one of the highest authorities on the subject, puts the death-rate of appendicitis at 14 per cent., and hopes it may be reduced to 12 per cent.

“With all respect to Dr. Hawkins, I myself look upon the above estimate of 14 per cent. as too low when hospital cases are considered. It is interesting to note that Dr. MacDougall in his address at Carlisle in 1896, quoting from returns made from the Edinburgh Royal Infirmary for the three years 1893, 1894, and 1895, found that the death-rate of acute appendicitis was 25 per cent., and that the returns of two London hospitals—St. Bartholomew’s, 1893 to 1895, and St. Thomas’s, 1892 to 1894—gave a death-rate of nearly 20 per cent., and it is doubtful if these returns included all the cases admitted of purulent peritonitis. . . .

* I use this term, etymologically unsatisfactory, because it is convenient and based on correct pathology.

"The advocates of waiting and watching further maintain that in the indiscriminating removal of appendices which they say has been going on in America, we have had an abuse of surgery similar to that which characterised, some years ago, the operation of oöphorectomy."

Ochsner (*Med. News*, May 2, 1903) advises that the operation be deferred in cases which are very grave when first seen, whether early or late in the disease. This advice only refers to cases which experience has shown to do badly after immediate operation.

Delay is recommended until the general condition has improved and localisation has occurred; and an operation can then be performed with comparatively little risk. In these cases and also in all cases of appendicitis, Ochsner strongly advocates absolute cessation of administration of any food or fluid by the mouth, and especially condemns the exhibition of cathartics, because peristaltic movements of the intestines spread the infection.

The mouth may be moistened and washed out, but all food and fluid must be given by the rectum. Gastric lavage is recommended for nausea and vomiting. In all acute cases seen before there is evidence of spread of the disease beyond the appendix, an immediate operation by a capable surgeon is advised to prevent complication as well as to save life.

These views are based on a study of 337 cases admitted into Augustana Hospital in 1902; 192 were acute cases, 145 chronic; the mortality of the acute cases was 3 per cent., or six deaths, three of which occurred without operation. Only one of 145 chronic or internal cases died.

"(b) *The Advocates of Operation at Once or at the End of Thirty-six or Forty-eight Hours.*

"Let us consider how this school, to which, I confess, I have felt myself drawn increasingly during the last few years, would answer the objections to early operation which I have just mentioned. And I will take the last first, viz., the criticism that this operation of early removal of the appendix has been abused, and the comparison between it and the similar abuse with which most of us are familiar as to oöphorectomy.

"There is an old saying that '*Abusus non tollit usum.*' A pendulum of opinion which sways strongly first in one direction, then in another, needs watching. And in my opinion there is a danger that in being influenced by the needless operations which have no doubt been done in America and elsewhere, we shall lose sight of the very sound and splendid work done by the best surgeons of that country. I shall allude to this more in detail shortly. I will only add that in this country hasty and needless operating will certainly not be the rule of treatment, but there is a risk that in priding ourselves on this we err on the other side. I am certain that the results of the best American surgeons are far superior to anything in this country, and are but little known amongst us.

"With regard to the comparison between removal of the appendix and the ovary, I scarcely think this holds good. A diseased ovary may cripple, but it very rarely kills; it is not a vestigial structure; though

unsound, it is not necessarily functionless. An appendix has not, like the ovary, peculiar importance not only to its owner, but also perhaps to others, an importance quite *sui generis*. The advocates of early operation would answer to the conservative school: 'You sanction, nay, perhaps you urge, operation as soon as evidence of gangrene, perforation, suppurative peritonitis, or local abscess is certain. But by the time the evidence is sufficient for you to call in surgery it is often too late; you admit that it is usually impossible to diagnose such conditions as gangrene and perforation till the disaster is announced by evidence which is unmistakable, but which announces a condition in which surgical interference is too often useless.'

"The advocates of early operation claim that by operating early, and thus making sure that infection has not extended beyond the appendix, the surgical death-rate would be much below the medical one, which we have seen to be put by one of the best authorities at 14 per cent. Thus Dr. Morriss holds that the death-rate should not exceed 4 or 5 per cent. when cases of gangrene, perforation, and suppurative peritonitis are operated on, and goes so far as to say that a surgical death-rate of 2 per cent. in cases operated on early 'would be illegitimate.'

"Let us examine this claim that the medical death-rate will be much lowered by early surgical interference. It will be seen to stand or fall very largely upon the meaning of the word 'early.' The question at once arises, 'How many cases are really seen within the first twenty-four or thirty-six hours?' Certainly, I think but few in hospital practice. Here the patient very often goes on working for days after he has had warnings of pain, and even sometimes with a lump in his right iliac fossa. We must face the fact that it will be difficult to determine whether, with this word 'early' before us, we really are dealing with the first twenty-four or thirty-six hours. A patient from carelessness or inaccuracy, or a desire to make the best of his case, from a dread of operation, may misrepresent his symptoms as just beginning. In reality this man has had, for a day or two, pain or other evidence that a catarrhal condition has been established, and thus the appendix epithelium has had time to become shed, and an infection-atrium has had the opportunity of forming before a medical man is asked to see the patient. Then, when the latter is called in, the pulse, temperature, pain, tenderness, and so forth betoken not the commencement of an attack, as the patient represents, but a stage in which an actual abrasion is present, perhaps even that the peritonæum is becoming infected.

"Having mentioned this caution, we will suppose, for the sake of argument, that all cases are seen within a really early stage, viz., twenty-four hours. Is it certain that early operation at this stage will be largely successful? Let us examine the ground on which we stand. If we accept Dr. Hawkins's mortality of appendicitis treated medically as one of 14 per cent. from gangrene, perforation of the appendix, and suppurative peritonitis, in order to ensure a surgical mortality of 4 or 2 per cent.—though Dr. Morriss is inclined to look upon even the latter as 'illegitimate'—it is clear that we must operate *successfully* on 96 or 98 cases of acute appendicitis in the early stage. This is a statement which there is no gainsaying, and it is one which

at once makes a mind capable of weighing evidence very thoughtful. When one considers the conditions under which this early operation may have to be done in a febrile patient with an infected, septic organ to be removed, with intestines very likely distended, and many other conditions present the very reverse of those which make an operation during the quiescent stage so successful, it is difficult to say how far the medical mortality of 14 per cent., or, perhaps more correctly, of 20 per cent., will be reduced, even if the surgery be always that of skilled hands. That it will be reduced by habitual earlier operation, and in the lifetime of some of us, I am certain; but I doubt if it will be brought below 8 per cent. when all the conditions and the different personal equations of the operators are weighed.

"But here it will be only just to examine some of the results gained by the best of those American surgeons who advocate early operation in every case. These results are not sufficiently known in this country.

"I will take only two of the more recent ones, viz., those of Dr. Mynter, of Niagara, and Dr. Morriss, of New York. Dr. Mynter (*Appendicitis*, p. 172), whose book emphatically bears the stamp of a candid and judicious worker, writing in 1897, had had 13 cases, all of which had more or less total gangrene but yet without perforation. They *all* recovered by prompt operation and extirpation of the appendix. Two cases were operated on during the first day, five on the second day, two on the third day, three on the fourth day, and one on the seventh day. 'These cases,' he goes on to say, 'are most interesting, as giving conclusive evidence of the importance of operating before perforation has occurred. No one can doubt that perforation with profuse peritonitis would shortly have occurred, and that they all would have died under any other than surgical treatment.'

"Dr. Mynter operated on another group of 20 cases, all of which had gangrene with perforation of the appendix, and commencing or diffuse peritonitis. Five of these recovered, while 15 died—13 of diffuse peritonitis, one of gangrene of the cæcum, and one of suppurating pylephlebitis after the peritonitis had disappeared. The five who recovered were operated on, in two cases on the first day, in two cases on the second day, and in one case on the third day. Of the 15 who died, one was operated on during the second day, two on the third day, five on the fourth day, two on the fifth day, four on the sixth day, and one on the seventh day.

"Dr. Mynter adds: 'Comment seems unnecessary; all died if operated on later than the third day.'

"Dr. Morriss's cases (*Lectures on Appendicitis*, New York, 1895) are somewhat less carefully tabulated, but are most instructive.

"Of 91 cases of acute appendicitis *operated on early*, in 59 in which *only the immediate vicinity of the appendix was infected*, although many of these cases involved extensive operative work, there was no death in this series of 59 cases.

"In six cases of intense general septic peritonitis, with the whole abdominal cavity bathed in pus, *only one patient died*.

"In three cases with intense general septic peritonitis, not marked by the presence of pus, *only one died*.

"In 23 cases of the walled-off abscess form of appendicitis, the

most varied complications were present. Five only of these died, but one of these deaths was from acute suppurative nephritis, a second from 'intestinal obstruction due to adhesions which could not be separated at the time of operation on account of the patient's condition,' and a third, already weak from several months' septicæmia due to an abscess overlooked before Dr. Morriss saw the case, died of a continuance of the septicæmia.

"This death-rate of seven in 91 cases testifies in no uncertain terms to the admirable care and skill which must have been exercised to attain such a result.

"Dr. Morriss is quite justified, after such success, in writing: 'I feel that the death-rate in 100 such cases as the list contains should not be more than 4 or 5 per cent., notwithstanding the fact that many of the cases were in a condition which seemed to prohibit interference.'

"It seems to me that even if this surgical death-rate of 4 or 5 per cent. were doubled, viz., 8 or 10 per cent., it would give a better result than the medical one of 14 or 20 per cent., and our duty would be clear."

More recent results are even better. Thus Dr. Murphy (*Amer. Journ. Med. Sci.*, August, 1904), in his very valuable paper based on 2,000 operations performed by him since 1889, states that the mortality of his first 100 cases was 11 per cent., but that has been reduced to 2 per cent. in his last 100 cases. About two-thirds of these patients were operated upon in the intermediate stage, but the statistics include all cases of suppuration, gangrene, and peritonitis.

Dr. Deaver (*Amer. Med.*, Oct. 17, 1903) reports 566 cases operated upon in 1902-3, with a total mortality of 5.3 per cent.

In the following interesting tables, all cases with no pus outside the appendix are labelled "appendicitis" (Deaver):—

TABLE I.

Peritonitis, general	16	5 deaths	31.0 %
Abscess cases	183	22 deaths	12.0 %
Appendicitis	367	3 deaths	0.8 %
	566	30 deaths	5.3 %

TABLE II.

Adults, acute	344	26 deaths	7.56 %
Adults, chronic	164	—	—
Children, acute	49	4 deaths	8.16 %
Children, chronic	9	—	—
	566	30 deaths	5.3 %

Dennis (*Med. News*, Jan. 9, 1904) records 119 consecutive operations with only two deaths, one due to empyema in an alcoholic tramp and the other due to subdiaphragmatic abscess and pulmonary abscess, and 28 of the patients had abscesses, and these include the two deaths. In 11, perforations and peritonitis had occurred, but all

of these recovered. Dennis strongly advocates early operation, free incision, and thorough drainage.

Mr. Paul (*Lancet*, vol. i. 1906, p. 674) reports 252 operations performed since 1901: there were 43 cases of abscess and 17 of peritonitis; the total mortality was 6·3 per cent. In the last year, however, the results had improved: 72 cases, including 16 abscess cases and 4 of peritonitis, were operated upon, with a mortality of only 2·7 per cent. Mr. Paul aims at interval operations, and only operates on acute cases when he has reason to suspect suppuration or peritonitis. It would be interesting to know how many cases seen in an acute attack and treated conservatively die of a subsequent attack which may come on before an "interval" operation.

Mr. G. R. Turner (*Lancet*, vol. i. 1905, p. 643) records 125 operations which were performed for acute appendicitis as soon as possible after the surgeon saw the patients. The mortality was 8 per cent.; and Mr. Waterhouse (*loc. cit.*) mentions 19 operations performed within the first twenty-four hours of the disease with no death, although perforation of the appendix was noticed in three cases.

Prof. Koerte reported 137 recent operations before the German Surgical Association (*Lancet*, vol. i. 1905, p. 1455). In 57 of these symptoms of peritonitis existed before operation; of the patients operated on before forty-eight hours 18 per cent. died, and of those operated on on the third day 36 per cent. died. All the cases without peritonitis recovered.

Prof. Kümmell (*loc. cit.*), who used to advocate conservative treatment, now prefers early operation, because he believes that the disease has become more grave. Only three patients died out of nine operated upon by him in the early stage.

"But the following cautions must be borne in mind:

"First, that we have here the results of especial experience of those who have had opportunities of acquiring especial skill. Dr. Mynter strikes a very important note when he emphasises the point that wherever the home surroundings are unfavourable the well-regulated operating-room of a home or hospital is a *sine quâ non*.

"Secondly, it is never to be forgotten that these operations are always serious, often very difficult, and that they require good experience, efficient assistance, and efficient antiseptic precautions.

"Thirdly, in estimating the surgical death-rate, which I do not myself expect to be less than 6 or 8 per cent., when all the conditions under which this operation will be performed are taken into account, we must remember that in certain cases of appendicitis beginning very acutely the operation, however early, will not save life. I refer to cases where a general peritonitis sets in early, possibly within the first few hours of the case coming under notice. The explanation of these cases probably is that in some it is not really a first attack. The history given is unreliable, the appendix is already a damaged one, and either gangrene or a perforation of its unhealthy structures sets in quickly, with the result of a rapid general peritonitis. In others, the explanation is that the bacillary activity is, from the first, acute, the resisting power of the patient's tissues very poor, or that some minute point in the anatomy of the appendix, as the gaps between the fibres of the muscular coats (*vide supra*), facilitates rapid transit of the septic

process. No one can tell how often the lives of our patients hang on such minute points.

"There is another of the points of dispute between the two camps to which I would ask your attention. The advocates of early operation maintain that many of the cures which are secured by medical treatment—we will call them 80 or 85 per cent.—are not permanent and complete cures when followed up; but that permanent mischief is left behind, sometimes slight, sometimes severe and dangerous; and that patients would be saved from the great annoyance and suffering of recurrent attacks and much waste of time if the appendix were removed in the first attack. The following is an interesting instance of how incomplete may be the cure of a case treated on medical lines, and of the thread on which such a patient's life may be hanging:

"A gentleman, aged 23, was sent to me in July, 1896, by Dr. Goodhart with the following history:—In 1895 he had had a severe attack of appendicitis, in which the temperature was for some days between 102° and 103°. Under medical treatment he made an apparently perfect recovery. In June, 1896, while bowling for an eleven of the Zingari at Manchester, as he shot up to the crease he suddenly felt an acute pain and dropped to the ground. He was carried to an hotel in a state of collapse, and when the mischief had abated came into my hands, as I have said. There was the characteristic thickened knotty lump and tenderness at one small spot in the right iliac fossa. The appendix, when removed, showed a good deal of thickening in its distal half, but, save for the adhesion of one single tag of omentum at one spot, it struck me as being strangely free from adhesions; considering the severity of the two attacks. The patient made a good recovery, and is now growing and exporting that excellent dry sherry, 'Pando,' at Xeres. I happened, after the operation, to pass a probe down the lumen of the appendix, when, to my surprise, the blunt end passed, without the slightest force, through the walls at a spot exactly where the tag of omentum was adherent. Here the end of the probe could be seen just covered by a filmy layer of peritonæum only. The chief events of the illness and the very narrow escape of the patient stood out very clearly. In the first severe attack, with a temperature of 103°, the appendix had suffered very severely; no walling-off life-saving adhesions had formed, save the one, single and ommental. As the patient was bowling his very best, the uplifted arm and rotation of the whole trunk upon one leg brought, by means of the latissimus dorsi, pectoralis major, and external oblique—all continuous with each other and with the muscles of the lower limb at Poupart's ligament—a violent strain upon the abdominal wall, and so upon the ommental tag, causing a stretching here, and perhaps a minute tear, and thus the agonising pain and collapse which heralded the onset of the second attack.

"There is one other of the points of dispute between the two schools to which, as a surgeon, I must allude. By the opponents of routine early operation it has been objected that such a course would be followed by a large number of ventral herniæ. There is, no doubt, truth in this, for the incision will, in many cases, have to be free in order to find the appendix and to enable the surgeon to get his field of operation thoroughly isolated with gauze tampons; secondly, drainage will often be required, but modern methods of operating in the abscess cases will do much to reduce the number of post-operative herniæ.

"But a ventral hernia must weigh lightly against a saved life. To put this matter succinctly, it will be better for such a patient to be fitted with an abdominal belt than to be measured for his coffin."

Such is, I think, a fair expression of the two camps of opinion on this subject.

For my own part, then, I consider that any physician is justified in asking a surgeon who is skilled in abdominal surgery and who has the necessary aids, &c., to remove the appendix as soon as the diagnosis is made. Again, I hold very strongly that every physician is not only justified in asking, but bound to ask, a surgeon skilled in this branch of surgery to interfere at the earliest possible moment in certain cases—viz., where the evidence of appendicitis is from the first severe and progressive. Of the evidence, the most valuable points are marked pain, tenderness, and vomiting. Next in value to these I should place the temperature and pulse. These may be fallacious,* the temperature often falling, due to septic absorption following perforation. Another guide to which I attach much importance is the early look of grave illness or anything approaching to the pinching of the “facies Hippocratica.” Two other points of evidence which are of great importance, but which, it is to be hoped, the surgeon will be allowed to try and forestall, are a tendency for the abdominal wall to become fixed and a tympanites spreading from the right iliac fossa. Leucocytosis, and especially a disproportionate increase in the polynuclear cells, may be of value when taken with other symptoms (Gibson, *loc. infra cit.*).

I should like to call attention to one other point to which I attach great importance, and that is, the position of the most marked tenderness, resistance, and swelling, if present. The more internal to McBurney's point this evidence is found, the greater the risk that perforation will light up a general peritonitis instead of one limited to the iliac fossa. We have learnt much of late years, from American writers (*e.g.*, Bryant and Fowler), of the importance of remembering the position of the appendix (*Ann. of Surg.*, vol. i. 1893, p. 164; vol. i. 1894, p. 12). It is clear that when the appendix is directed internally not only is the risk of general suppurative peritonitis greater if the appendix perforate, but if a localised abscess form it is more likely to communicate with the pelvis, and perhaps open into the rectum or vagina; if adhesions form about it there is a greater risk of much more important structures being involved—viz., the iliac vessels, ureter, bladder, &c.—than if the appendix be directed downwards, when it may be only adherent to Poupert's ligament. Many other instances of the practical bearing of anatomy upon the different positions of the appendix will suggest themselves.

I will now allude more particularly to one sign which I have only mentioned above, viz., swelling. Although some degree of swelling is usually present in the right iliac region, it cannot be too strongly insisted upon that in cases of “fulminating” appendicitis there may be no swelling from first to last.† In a very few cases swelling is absent

* In Mr. G. Barling's words (*Brit. Med. Journ.*, vol. i. 1895, p. 1135), “the temperature is an uncertain guide, and one only to be relied upon when confirmed by other phenomena. If it present the paradox of a falling temperature with a quickening pulse the improvement in the former would be a fallacious guide. . . . The great point in recognising these cases is not to regard any one point as essential to diagnosis. It is desirable to dwell not so much on the absence of one particular feature, as upon the intensity of those which are present.”

† Some cases mentioned by Dr. Tyson, of Folkestone, at one of the discussions on this subject at the Clinical Society (*Lancet*, vol. i. 1892, p. 424), form good instances of the truth of this. In three cases in which, after mild symptoms had lasted for three days

from the right iliac fossa, but present elsewhere owing to the appendix being misplaced. Thus, a very few cases of left-sided appendicitis have been recorded. Dr. Fowler (*Ann. of Surg.*, 1894, vol. i. p. 160) publishes a case in which there was marked tenderness in the direction of the gall-bladder. No appendix could be found in the usual place, as it lay behind the liver. Again, rectal examination may reveal a pelvic swelling.

It will be seen that the above opinion of mine, that any physician is justified in asking a surgeon skilled in this branch of surgery to operate in cases of appendicitis in the earliest stages, and that he is bound to do so where certain evidence just given points to probable rapid perforation, is not the same thing as sanctioning the removal of the appendix as a routine practice by anyone who thinks himself competent to do so. Considering the increasing tendency at the present day for surgery to be taken out of the hands of properly qualified surgeons, men with a *bond fide* and lifelong hospital training, and for it to pass into the hands of those who have no such ripe experience, no such operative training, and who are occupied with other work and other claims not always running on smooth lines with aseptic surgery—considering this and its effects, any such wholesale and routine removal of the appendix would be attended with disastrous consequences.

Since Mr. Jacobson expressed his views more recent results have amply confirmed them. The results have improved, partly because the surgeon is called earlier and partly because surgical methods have improved with wider knowledge and experience, and especially because early operation has become more and more popular with both surgeons and physicians.

At the present time it is practically certain that the ideal treatment for all cases of acute appendicitis is an operation performed by a capable surgeon within twenty-four hours of the onset of the attack, for no one can foretell the course of the disease in any individual case; it may be towards recovery in the great majority of patients, but in many perforation, suppuration, or suppurative peritonitis will occur, and the patient's life may be sacrificed by delay.

No one can tell a patient that he will do well, but only that a certain percentage of about 85—90 will recover with conservative treatment. Nor can anyone even guess with moderate accuracy the existing condition of the appendix in any given case at any time; patients who have been able to walk to the hospital within a few hours of the supposed onset of their disease have been found upon immediate operation to possess gangrenous appendices. Such an appendix need not necessarily give any symptom until it perforates and sets up peritonitis.

If an operation could be performed within twenty-four or thirty-six hours of the onset of symptoms, most of the deaths which now occur from abscesses, suppurative peritonitis, and complications would be prevented. Troublesome complications like *fecal fistula*, *empyema*, *pylephlebitis*, *thrombosis of veins*, *pulmonary embolism*, and *ventral hernia*, would also be largely avoided. Unfortunately, a great many patients

there was sudden collapse and death, there had been sickness and tenderness, but no swelling. Operation was performed in one case unsuccessfully. In all three suppurative peritonitis following perforation of the appendix was found.

are not seen by a surgeon or physician until the most favourable time for operation has passed. Too absolute reliance must not be placed on time as an indication of the progress or stage of the disease, for in some cases perforation, gangrene, or even peritonitis may be discovered only a few hours after the onset of symptoms.

The writer's* conclusions on the important question of operation for appendicitis are briefly as follows :—

(1) An operation by a capable surgeon should be advised in all acute cases, as soon as possible after the diagnosis is made, and, if possible, within twenty-four or thirty-six hours of the onset of symptoms.

(2) In cases seen for the first time two or three days after the onset of symptoms, if the signs as well as the symptoms are subsiding, conservative treatment may be recommended. A radical operation is advised after the first attack, for no one can say that another may not occur; and it is not possible to foretell the nature of the second or subsequent attack. One attack predisposes to another, and, as a rule, the attacks increase in severity.

(3) In cases first seen later than thirty-six to forty-eight hours from the onset, if the symptoms and signs are severe and not abating, and are such as to indicate the probability of existing or impending suppuration, an operation should be performed without delay, for these abscesses often increase in size very rapidly and may burst in any direction, frequently with disastrous consequences. Early operation may prevent general peritonitis, fæcal fistula, pyelophlebitis, pulmonary complications, septicæmia, &c.

(4) An immediate operation is indicated when there is even a reasonable suspicion of the existence of peritonitis. Recent results show that a very large proportion of these very serious cases can be saved by a timely and rapidly performed operation by a surgeon experienced in abdominal surgery (*vide infra*).

Operative Interference in Acute Appendicitis with Abscess.—Directly suppuration is diagnosed or reasonably suspected at any stage of the disease an operation must be undertaken without delay.

A few years ago there was a tendency to wait until the abscess was thought to be safe—*i.e.*, till it was walled in by adhesions, and generally till it showed signs of being adherent to the abdominal wall—the reason given being that, if opened before, the risk was great that the peritoneal sac would become infected. On the other hand, it is clear that in waiting we run serious risks, for (a) the abscess may rupture and burst into the peritoneal sac, especially if the patient is restless; (b) the pus will burrow, *e.g.*, into the pelvis, opening into the rectum or bladder, downwards under Poupart's ligament or backwards and upwards to the loin, all these directions being influenced by the position in which the appendix was lying before the attack.

Delay greatly increases the mortality and the risks of all the complications of the disease. These risks being increasingly recognised, there is a general tendency to try and find the pus early. The following is the best evidence as to the early existence of pus :—Persistence and increase of the symptoms, both local and general, after thirty-six to forty-eight hours; marked local resistance and tenderness †; a persistent and

* R. P. R.

† This may be masked by unwisely given opium.

usually progressive swelling* ; impaired resonance in the flank, loin, or groin ; bulging into the pelvis, especially if unilateral or uneven.

Leucocytosis, if increasing, is sometimes of value as confirmatory evidence, but it is not to be relied upon for negative evidence. In no case with a count of 35,000 was pus absent, but in many with only 15,000 pus was found (French, *Pract.*, June, 1904).

A disproportionate increase of the polynuclear cells is of more value.

Dr. Gibson (*Ann. of Surg.*, 1906, vol. i. p. 483) concludes from a *differential* count in 20 cases of acute appendicitis that it is of real value, "all the severer lesions, those with gangrene of the appendix or progressive peritonitis, and all the fatal cases, showing a rising line on the standard chart."

It is in these severe cases that aid is needed, for the early symptoms may be obscure and perplexing. No reliance must be placed on negative evidence obtained from this source, if the symptoms and signs indicate the probability of suppuration or peritonitis.

The diagnosis of suppuration should of course be made after a careful study of all the available information, and a conclusion should be arrived at long before the appearance of the time-honoured symptoms of hectic fever, œdema, fluctuation, and redness. An attempt should be always made to determine the position of the abscess and appendix.

Dulness and tenderness in the loin and pain along the outer side of the thigh indicate a high and generally a retrocæcal position.

Rectal or vaginal examination, bladder and rectum troubles, and the absence of a swelling in the iliac fossa may strongly suggest that the appendix is in the pelvis.

Operation.—The skin having been shaved and cleansed, an incision three to four inches long is made parallel to the fibres of the external oblique, and with its centre over the middle of any swelling or induration that may be discovered and located, perhaps for the first time, when the patient is under the anæsthetic. As a rule the centre of the incision and swelling will be a little below the lower point of trisection of the line drawn from the umbilicus to the anterior superior spine of the ilium,† but when the swelling and dulness are unusually high and far back, so must the incision also be ; and when there is reason to believe that the abscess or appendix is unusually low, the incision must be made as low as possible without endangering the deep epigastric vessels.

The fibres of the external oblique are separated and well retracted by means of tissue forceps or hooked retractors ; and the fibres of the internal oblique and transversalis muscles are then separated by blunt dissection, as recommended by McBurney years ago (*Ann. of Surg.*, 1894, vol. xx. p. 38). Should more room be required, the rectus sheath may be opened and the muscle drawn inwards, as suggested by Harrington (*Boston Med. and Surg. Journ.*, August, 1899) and Weir (*Med. News*, Feb. 17, 1900, p. 241).

* The swelling may be very slight or difficult to detect from the rigidity of the abdominal walls and the flinching of the patient unless an anæsthetic be given.

† This incision is very greatly to be preferred to one in the linea semilunaris, and *à fortiori* to one in the linea alba, because it gives very much more direct access to the parts concerned. If one in the linea semilunaris be made it will be found that the outer edge of the wound often requires to be strenuously drawn aside to enable the surgeon to get at the appendix. This use of the retractor may lead to bruising of the wound. Again, if a surgeon working in the linea semilunaris needs, as is often the case, to come low down, the deep epigastric vessels must be divided.

The muscles are thoroughly retracted, and the transversalis fascia and peritonæum are carefully incised in the same direction as the skin wound.

In those cases—and they form a large number—where the abscess is made additionally safe by becoming adherent to the abdominal wall, the surgeon will have a hint given him of the presence of this condition by the oozing and inflammatory matting of the deeper layers as he divides them.

We will suppose a more difficult case with no such tendency of the abscess to come forward through the abdominal wall. When the peritonæum is carefully divided the structure which most probably first presents itself is the omentum, matted down into the iliac fossa, perhaps adherent to the ileum, cæcum, or the neighbourhood of Poupart's ligament. This being separated off, or secured and divided in several pieces, a mass is found which consists of small intestine, cæcum, and appendix. Before this is dealt with it must be shut off from the rest of the peritonæal cavity by tampons of sterile gauze. The operator then endeavours to find any evidence of a longitudinal band which will denote the cæcum and may lead to the appendix itself. This help is rarely forthcoming, because inflammatory changes obscure localising structures. Careful blunt dissection in the direction of greatest œdema and matting, and towards the centre of the swelling, is more reliable.

If the surgeon find one or more coils of intestine he gently separates one from the other, or turns the whole mass upwards carefully from the fossa, and, while doing so, probably gives rise to an escape of pus. Perhaps the site of this may be recognised by a yellowish sloughing spot. The pus is carefully mopped away as fast as it escapes. If large in amount the patient must be turned on to his right side to expedite the flow and preserve the peritonæal cavity from contamination.

In a patient sent to me by Dr. Dakin, after tying off a sheet of omentum, a large mass appeared in which I could not differentiate large or small intestine. No appendix could be seen or felt. On gently turning up the whole mass a sloughing spot was seen below, from which a blunt-pointed director gave vent to two drachms of pus. Pressure on the mass was now made, but no more pus escaped, and as no stercolith could be detected, a gauze drain being inserted down to the spot, I closed the rest of the wound by three layers of buried sutures (*vide infra*). A good recovery followed, and the patient has been able again to take briefs at assizes.

When the pus has been let out, the surgeon has to decide the important question whether the appendix should be removed or not. The majority of surgeons consider that this should be done only when the condition of the patient is good, and the abscess is of small size, and the appendix can be found without much delay. (A.) Thorough drainage only is suitable for very large and late abscesses, for in them the appendix is so greatly disorganised in most cases, that recurrence is unlikely.

Sir Frederick Treves (*Lancet*, vol. i. 1905, p. 569) in his introduction of the interesting discussion which took place before the Medico-Chirurgical Society in 1905 stated that recurrence of symptoms occurred in less than 17 per cent. of the cases in which the abscess was merely drained. Mr. Pearce Gould gave a lower estimate of 10 per cent.

Moreover, the condition of patients with large abscesses is often too serious to allow a prolonged and perhaps fruitless search, during which thin limiting adhesions may be unknowingly torn deep in the wound, setting up general peritonitis. The sodden and inflamed intestines may also be damaged, and a fæcal fistula produced, by a too zealous pursuit of the appendix in some of these cases. Treves,* Pearce Gould, Bennett, Murphy,† and other recent authorities agree that it is not wise to attempt to remove the appendix in all cases. If, owing to the persistence of a sinus or to later attacks of inflammation, its subsequent removal should become necessary, this can be done under much more favourable conditions. Some surgeons, on the other hand, make a great point of removing the appendix in every case. Dr. O'Connor, of Buenos Ayres, for instance, says (*Glasgow Med. Journ.*, September, 1899): "I made it a rule, some years ago, never to quit the abdomen, when operating for appendicitis, without taking the appendix with me." Mr. Lockwood also (*Appendicitis*, 1901) considers "that it is better for the patient to take the immediate risk of a determined attempt to excise the appendix, but how far the attempt should be carried must depend upon the peculiarities of each case"; and he quotes several cases where subsequent trouble arose from leaving an infected appendix.

Although recurrence and other troubles do undoubtedly sometimes arise when the appendix is left, the proportion of cases in which they occur is certainly comparatively small—Mr. Lockwood puts it at 15 per cent.—and therefore hardly justifies the greatly increased risk of the primary operation if the appendix is removed in every case. The appendix, therefore, should be removed, if this is possible without greatly increasing the risk of the operation; but where it forms part of the abscess wall, or where it cannot be found after a reasonable search, the wiser and safer plan will be to leave it. When found free in the abscess cavity, a transfixion of the base of the mesentery with an aneurysm-needle carrying a loop of silk, one-half of which is thrown round the appendix and the other round the mesentery, the ends cut short, and the appendix and its mesentery amputated just beyond the ligature, will probably be found sufficient. Any projection of the mucous coat should be disinfected. Whether it be removed or no, if a perforation be present, search should be made for a possible stercolith, as a fistula may follow for some time if one of these be left behind. Free drainage must be adopted, and the wound should be only partly closed.

(B.) When the amount of pus is small and the condition of the patient is good, the pus may be carefully mopped away, and the appendix sought. The wound being well opened out and the adjacent peritonæal contents shut off with tampons of iodoform gauze, the appendix is separated, if possible, from any adhesions present, and dealt with according to one of the following methods. If gangrenous, it should be cut away as near to the cæcum as is safe, and if its coats here will not bear ligature and sutures, the stump must be disinfected with pure carbolic or nitric acid, and a cigarette drain should be inserted near it.

* *Med.-Chir. Trans.*, 1905.

† *Amer. Journ. Med. Sci.*, August, 1904.

Little fear need be entertained that a fæcal fistula may result from failure to ligature or invert the stump in suppurative cases, although a slight leak may occur in some cases for a day or two, but it is probable that the temporary fistula is from the extension of necrosis to a contiguous coil of the ileum.*

When the appendix is inflamed and soft, but not actually gangrenous, it will be quite sufficient to trust to ligature with medium-sized sterilised silk close to the cæcum. If the state of the patient or the softened condition of the appendix prevent anything more being done, these measures will be found quite sufficient, if pure carbolic acid be applied to the mucous membrane on the stump so as to disinfect this. If the appendix, where cut through, be healthy or only thickened, one or other of the following methods may be adopted.

Mr. Barker (*Brit. Med. Journ.*, vol. i. 1895, p. 863) recommends the following method of double ligature as being simple and rapid. It is based on the fact that when the appendix is much thickened the mucous and sub-mucous coats can, after circular division of the other coats, be drawn out in an unbroken tube. The mesentery having been first transfixed, tied, and severed near the cæcum, the serous and muscular coats are divided circularly about three-quarters of an inch from the cæcum. The mucous and sub-mucous tube is now drawn out, and the outer coats having been stripped back, as in a circular amputation, towards the cæcum, the above-mentioned tube is tied close to its juncture with the cæcum with fine silk and cut off. It at once retracts. The outer tube is drawn down over it and tied with fine silk or gut. Another plan, which is equally rapid and satisfactory, is to ligature and remove the appendix close to the cæcum, then to invert the stump of the appendix into the cæcum by means of a circular purse-string suture, situated about a quarter of an inch from the stump, all round. This, when drawn tight and tied, inverts the stump of the appendix. However the appendix is removed, when it is severed, any escaping contents must be received on gauze, &c. The meso-appendix must always be looked to, its artery properly secured, and if its stump can be drawn over that of the appendix, this will suffice in place of any more elaborate methods. Where the surgeon is in doubt about dispensing with drainage and closing his wound entirely, the extent and severity of any infective process, and the completeness with which he has been able to disinfect the deeper parts of the wound, must aid in the decision. The safest course in doubtful cases will be to leave the wound partly open, leaving enough room for a cigarette drain between the catgut sutures, which are used to approximate the muscles. Provisional sutures of fishing gut are inserted at the site of drainage, which can be tied on removing the tube and gauze packing after thirty-six hours or more. The risk of ventral hernia is now reduced to a minimum by the adoption of this and other valvular incisions in cases of localised abscess as well as in the

* Corner (*Clinical and Pathological Observations on Acute Abdominal Diseases*, 1904) examined seven cases of fæcal fistula arising after operations for acute appendicitis; in five the leak was in the ileum, and in two the cæcum had perforated; but not one fistula had arisen as a result of imperfect closure of the appendix stump.

"interval" cases. When the tube is removed the natural tension of the separated muscles serves to close the deep part of the wound.

Should the gridiron incision not give enough room even when the exposed rectus is well retracted inwards, then in rare cases of retro-cæcal or pelvic abscess the fibres of the deep muscles may have to be cut across either upwards or downwards, and afterwards most carefully sutured. In most cases, the surgeon will avoid this necessity by taking care to place his incision to suit each individual case, and by not following too slavishly any classical operation.

In some cases, the healthy peritonæum may be opened in this operation, and an abscess then discovered to be retro-cæcal and bulging on the posterior wall. I then prefer to make another incision further back towards the loin, and to drain the abscess in this situation, without risk of contamination of the general peritonæum. By careful packing, however, the surgeon may be able to evacuate a small abscess through the anterior incision without much risk.

In very rare cases it may be safe to open a pelvic appendicular abscess through the vagina or rectum when the mucous membrane is felt to be œdematous and bulging. It is, however, far safer to make an abdominal incision for exploratory purposes in all cases, whether it is decided afterwards to drain the abscess through the pelvis or not. Mr. Barnard mentions 10 successful cases in which this treatment was adopted (*Lancet*, vol. i. 1904, p. 510).

I believe that the gridiron incision is especially valuable in abscess cases, in which ventral hernia is otherwise very apt to develop. When the muscle fibres are cut across in these cases, and drainage is needed, a ventral hernia is the natural result, and there is a considerable risk of this even after the adoption of separation of the fibres of the rectus muscle, for the wound is a direct one as a rule. There is little doubt that the liability to cellulitis of the abdominal wall is increased by adopting either the gridiron incision or the operation through the rectus sheath; but this risk has been exaggerated.

Operative Interference in Suppurative Peritonitis.—The perforation here is due either to the acuteness of an infective process, to the pressure of a stercolith, to both combined, or to the rupture of a collection of pus. It is important to bear in mind these, the chief causes, as the evidence, both before and later, may vary somewhat. Thus, suppurative peritonitis may come on without the preliminary warning of a swelling (p. 296), as when the peritonitis is not preceded by an abscess. Again, when the rupture of an abscess is the cause of the peritonitis the characteristic symptoms of collapse will be more marked.

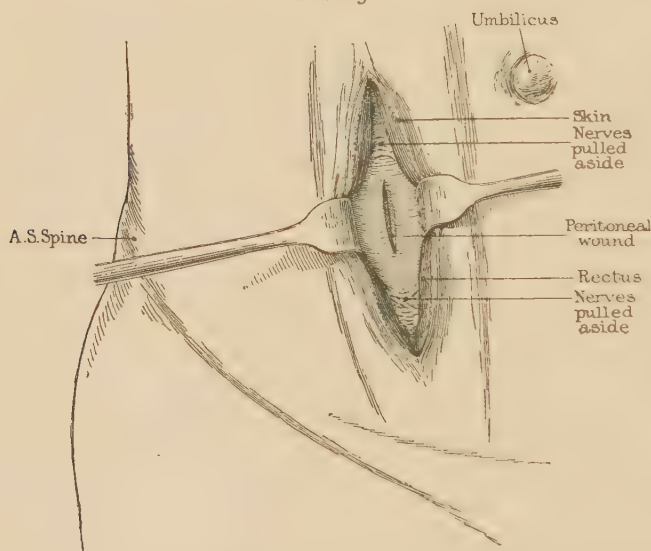
The warning* symptoms will be chiefly those given at p. 296—viz., a case often severe at first, and progressively so, severe pain, marked general abdominal tenderness, rigidity, perhaps a swelling, tympanites

* Dr. D. B. Lees's cases (*Clin. Soc. Trans.*, vol. xx. p. 135) show that a perforation communicating with the peritonæal sac, as long as this is shut off, does not give rise to collapse, and that the pain, tenderness, &c., may be so comparatively slight as to make it appear that operative interference is hardly justifiable. Yet under these circumstances the delay of a few hours may be fatal.

spreading from the iliac fossa, early immobility of the diaphragm and abdomen, obstinate vomiting, early and persistently rapid pulse, and a temperature* rising after a preliminary drop. Later on marked distension, absence of any peristaltic movement, constant vomiting of the effortless regurgitation type, a pulse increasing in quickness and failing in strength, the drawn-up knees, and the facies Hippocratica—all these are time-honoured evidence which will show that while surgical interference may be right, it will probably be futile in most of these late cases.

The results of operations for this grave condition depend very much upon four things:—(a) The nature of the bacterial infection, streptococcal cases and those due to the bacillus pyocyaneus being almost

FIG. 85.



The incision through the rectus muscle, the fibres having been separated from below upwards.

hopeless whatever is done, but fortunately these cases form but a small minority (Dudgeon and Sargent, *Lancet*, vol. i. 1905, p. 792): those due to the bacillus coli communis alone are much more hopeful; (b) early operation, before the peritonæum is irretrievably damaged, and the patient hopelessly poisoned; (c) the speed and judgment with which the operation is conducted; and (d) perseverance in the after-treatment.

It is very important therefore to operate without delay, and also to have everything that may be needed during the operation quite ready before the anæsthetic is given. In some cases it is necessary to infuse,

* Too much attention is not to be paid to these. In Dr. Fowler's words (*Ann. of Surg.*, vol. i. 1894, p. 153), "a lowering temperature and a lessening pulse-rate are not inconsistent with impending ulceration, perforation of the appendix into an unprotected peritoneal cavity, complete gangrene of the organ, or rupture of an appendicular abscess into the cavity of the peritonæum."

and bandage the limbs firmly over cotton wool, before an operation can be undertaken. Meanwhile everything should be got ready for the operation. As soon as the patient is anæsthetised with A.C.E. or ether, and the abdomen has been rapidly cleansed, a vertical incision about four inches long is made over the lower part of the right rectus muscle, and towards its outer border, beginning on a level with the navel. The muscular fibres are either drawn inwards, as originally recommended by Battle (*Brit. Med. Journ.*, 1895, vol. ii. p. 1360), or separated, as advocated by Lennander (*Centralblatt für Chirurg.*, 1898, vol. xxv. p. 90). To avoid hæmorrhage it is best to separate the fibres from below upwards. After any bleeding has been stopped, the posterior wall of the rectus sheath and peritonæum are opened in a vertical direction, care being taken to avoid injuring the distended intestines. Pus generally escapes at once, and should be mopped away. The wound is held open with large retractors, but the intestines should not be allowed to prolapse, for much delay will ensue if this happen, owing to the difficulty of replacing them, and shock will also be greatly increased by the manipulations and exposure. The pus is rapidly but gently mopped up with rolls of aseptic gauze until a clear view can be obtained, and the cæcum and appendix are then sought, and if diseased,* the latter is removed as quickly as possible, no time being wasted in needless details of treatment of the stump. It is quite enough to apply two ligatures, one in the meso-appendix and the other round the stump of the appendix close to the cæcum. If the appendix is gangrenous at its base and will not hold a ligature, it can be cut off flush with the cæcum, and the orifice inverted if possible by means of a purse-string suture. Neither a ligature nor inversion is imperative, but a "cigarette" drain must be inserted close to the stump.

If there is any difficulty in finding the appendix, it is best to look for its *root*, about an inch below and behind and a little to the right of the termination of the ileum. If it cannot be brought into the wound, a small counter-incision may be made directly over it; or the appendix may be left, for it must not be forgotten that it is not absolutely necessary to remove the appendix, but only to cleanse the peritonæum and drain it. The peritonæum should be mopped as dry as possible, especially the pelvic part of it; but care must be taken not to rub away protecting lymph and expose raw and absorptive surfaces. There are still differences of opinion concerning the wisdom or folly of irrigation in these cases. It is not possible to thoroughly cleanse the peritonæum by this means alone, and it may carry the infection further afield, between the liver and the diaphragm for instance; and it takes time to carry out properly. I have given up using it in appendicular cases, believing that it does more harm than good, and that swabbing is far superior to it. Clark and Norris (quoted by Hotchkiss), however, state that irrigation does not increase, but decreases, the danger of pyogenic infections.

Murphy (*Amer. Journ. of Med. Sci.*, August, 1904), from an

* If the appendix is healthy, it is probable that a perforated duodenal or pyloric ulcer has given rise to the symptoms, or more rarely perforation of a pyo-salpinx. The wound must then be enlarged upwards or downwards.

experience of over 2,000 cases, strongly condemns irrigation; and his results prove the efficiency of his treatment. He states that in two and a half years' experience he only had one death from general suppurative peritonitis. Later Le Conte (*Ann. of Surg.*, vol. i. 1906, p. 231) states that Murphy only lost one of his last 29 cases of suppurative peritonitis.

Sargent (Dudgeon and Sargent, *Lancet*, vol. i. 1905, p. 792) states that in 25 cases he used free irrigation, with more or less evisceration in 19, and 18 of these patients died. In his last six cases he only used local swabbing, and all of the patients recovered.

At St. Thomas's Hospital between 1899 and 1903 there were 119 cases of general suppurative peritonitis arising from appendicitis. In 100 of these free irrigation was used, and 80 of the patients died; the remaining 19 were treated by local sponging or washing, and nine recovered, a mortality of 47 per cent.

It must not be forgotten, however, that figures are not to be relied upon too absolutely; and the undoubted and general improvement, which has been noticed recently, in the results of operations for general suppurative peritonitis, is partly due to the fact that the surgeon gets his opportunity earlier, and also that every surgeon realises more and more the great importance of speedy work in these cases.

Blake (*Ann. of Surg.*, August, 1903) prefers irrigation to sponging because it can be carried out through a comparatively small wound, and the damage done is less, and the toxins more diluted and removed.

Dr. Hotchkiss, writing quite recently (*Ann. of Surg.*, vol. ii. 1906, p. 197), still advocates irrigation of the appendicular and pelvic regions, and he states that his mortality was only 11 per cent. in the 43 cases of diffuse peritonitis which were operated upon by him since 1899. These results are certainly very good, especially as Dr. Hotchkiss states that he took care to determine the extent of the peritonitis. A protest may be made here against the too common practice of publishing cases of localised and large collections of pus as instances of general peritonitis. Before 1899 Dr. Hotchkiss used irrigation and evisceration, and between 1895 and 1899 he treated 12 cases of diffuse peritonitis, with 11 deaths. Hotchkiss now finds the appendix, through a gridiron incision, often more by touch than by sight, and, like Blake, frequently does not drain the peritonæum, but only the abdominal wound. I certainly do not recommend closing the peritonæum in any case of general suppurative peritonitis, however well the cavity may have been cleansed. One of the chief objects of the operation is defeated if this plan is adopted. Drainage is essential. Evisceration and cleansing the individual coils of intestine has been tried and found to be accompanied with much shock, delay, and a high mortality. Moreover, it is a bad thing to remove the protective patches of lymph that nature has provided, "the shingles of protection," as Murphy calls them. The pus or sero-pus having been quickly mopped away as far as possible, especial attention being paid to the pelvis and kidney pouches, perforated large-sized rubber tubes, with gauze wicks inside them and a thin layer of gauze outside, are passed one towards the appendix, one into the pelvis, and one to the right kidney pouch just below the liver, and another into the left iliac fossa in some cases.

The appendicular region and the right kidney pouch can be most efficiently drained by bringing the end of the tube out through a stab wound in the loin. In women the pelvis may be drained through a perforation of the posterior vaginal wall into the pouch of Douglas. The wound is partly closed by means of stout fishing gut passed through the whole thickness of the abdominal wall by means of large curved needles, or a similar needle on a handle; and the drainage tubes are fixed in position by means of large aseptic safety pins. In some very late and grave cases, no attempt should be made either to remove the appendix or to close the wound, but only to let the pus out and establish drainage. In some cases with obvious distension and probable paralysis of the small intestines, it is wise to let out their poisonous contents either at once or after a day or two under cocaine anæsthesia. This can be done by bringing out a coil of the ileum or the cæcum* and packing some gauze around it, and then inserting a trocar and cannula or a temporary enterostomy tube of small calibre opposite to the mesenteric border and in the centre of a circle formed by a pursestring suture, which can be used either to close the hole in withdrawing the cannula or to fix the enterostomy tube *in situ*. A solution of magnesium sulphate may be injected into the bowel through the cannula or enterostomy tube. Many of these patients die from paralytic distension of the bowels, from which a timely and temporary enterostomy might save some of them.

In one of my most desperate cases, a longitudinal incision was made into a coil of small intestine, and the putrid contents, which were under great tension, squirted across the room. When a large quantity had been evacuated, the incision was rapidly closed by inversion. Next day, however, the distension again became great, hampering the respiration, so that an opening had to be made again into the coil which had been left in the wound, surrounded by gauze packing. The relief was immediate, and for some days a thin evil-smelling mucous and sanious discharge escaped from the puncture, but after four days the bowels began to act naturally, and the artificial anus which had been so valuable was closed by inversion, and the patient made a rapid recovery, although he developed diphtheria early in his convalescence.

After-treatment.—To prevent or lessen shock, the operation should be quickly performed under ether or A.C.E. and not chloroform; and the patient should be kept warm during and after the operation. Care is taken also not to allow too much exposure of the intestines. During or soon after the operation infusion may become necessary; continuous or repeated infusions into the subcutaneous tissues or into a vein are very much more valuable and safer than large and hurried injections into a vein. These should be resorted to when the pulse becomes rapid or small, or when the sphygmometer indicates a fall of the blood pressure (Lockhart Mummery, Hunterian Lectures, *Lancet*, vol. i. 1905, pp. 696, 777, 846).

The best solution to use is physiological normal saline, and tabloids containing the proper proportion of the salts of the serum can now be bought. Failing this, '9 per cent. solution of sodium chloride may be

* Greenough (*Boston Med. and Surg. Journ.*, May 19, 1904) prefers to make an opening in the cæcum if the latter be distended, because the fistula is more likely to close spontaneously. He gives a short account of 41 cases in which drainage of the intestine was tried.

used, and to it may be added adrenalin in the proportion of 1 to 20,000, as recommended by Mummery. A 6 per cent. solution of dextrose is safer for intravenous injection; two pints may be given in a little over twenty minutes (Dr. Beddard, *Guy's Hosp. Gazette*, 1905, vol. xix. p. 308). The temperature of the solution should be about 103—105° F. to allow of some loss of heat in transmission to the body.

Murphy (*loc. supra cit.*) administers saline solution by the rectum. A nozzle with several perforations in it is introduced into the anus, and connected by means of a rubber tube with a rubber bag, which is fixed only a few inches above the level of the rectum. The fluid trickles in about as fast as it is absorbed, and about twelve pints may be absorbed in this way in twenty-four hours if desired. The tube may be disconnected from the nozzle when required, but the nozzle should be left in position to avoid disturbance and pain in its reintroduction.

It is an advantage for the nozzle to have several apertures, so that flatus may pass without arresting the flow of fluid.

In my experience it has not been easy to administer fluid in this way when the patient is kept in the semi-sitting or Fowler position. Moreover, in the very worst cases absorption by the rectum is poor, so that continuous subcutaneous or venous infusion is more practicable.

Strychnine is strongly condemned by Crile from his experiments on animals, during which he discovered that the surest and quickest way to produce shock was by the injection of strychnine, although it did not necessarily cause twitching.

Mummery (*loc. supra cit.*) from his clinical experience with the aid of the sphygmometer came to the same conclusion. To administer strychnine or stimulants in cases of shock is like "beating a dying horse": it may induce a desperate effort, but it hastens the end. Subcutaneous injection of aseptic ergot in half-gramme doses is recommended by Mummery, and its effects last longer than those of adrenalin.

As soon as the temporary depression that follows the operation is over, the patient should be placed in the semi-sitting posture so strongly recommended by Fowler* and adopted by nearly all American surgeons. Murphy, Le Conte, and Hotchkiss speak very highly of this plan; and I have used it in a few cases with marked benefit. It is not easy, however, to keep the patient in this attitude, and a special but simple bed rest is necessary to enable the nurses to keep him up properly. The advantages of this attitude are undoubtedly very great. The weight and pressure are taken off the lungs, so that respiration becomes easier and pulmonary complications less likely. Percolation of the peritoneal fluid towards the pelvis is encouraged so as to facilitate drainage and also to divert the poisonous fluid to a far less absorptive part of the peritonæum, for

* R. S. Fowler (*Med. News*, May 28, 1904) states that "from October 17, 1899, to January 17, 1904, Dr. George R. Fowler and myself have operated upon 100 well-marked cases of diffuse septic peritonitis resulting from inflammation of the vermiform appendix. We have not refused operation to any case, however desperate. Of these cases 67 per cent. have resulted in recovery." Before the adoption of elevation of the head and shoulders in the after-treatment only 25 per cent. of the cases recovered. Dr. Fowler irrigates the peritonæum very freely during the operation.

it is well known that the diaphragmatic peritonæum is very absorptive, whereas the pelvic lining absorbs but little. When there is much adhesion of the coils, gravity is not able to attract the fluid to the pelvis to any great extent, but it may at least prevent fluid from ascending towards the diaphragm.

Murphy attempts to prevent peristalsis by giving nothing by the mouth for twenty-four to forty-eight hours, and by administering opium. Any food that may be necessary is given by the rectum.

Hotchkiss washes the stomach out before the patient leaves the table and introduces 3j. to 5ij. of saturated solution of Epsom salts into the stomach, giving no morphia, as he believes with most surgeons that purgatives, and not opium, are indicated in these cases.

Nux vomica and belladonna are valuable as excellent stimulants of the muscular wall of the intestine, but no cathartic will act in late cases with paralytic distension. Enterostomy is indicated in them.

I should certainly not give any opium or morphia in any case where I had reason to suspect paralytic distension of the intestines. A turpentine enema is of great value in some of these cases.

Prognosis.—The figures already given serve to show that our views of the prognosis of suppurative peritonitis must be considerably modified, but, even with all the recent improvements in the treatment, the surgeon cannot hope to save lives which have already been too gravely risked by delay, so that the mortality will probably continue as high as 30—40 per cent. for some time to come. Quite recently, however, one of us (R. P. R.) has operated upon seven consecutive cases of general suppurative peritonitis with only one death, although some of the patients seemed to be in a hopeless condition upon their admission. The patient who died was suffering from a perforated duodenal ulcer, which had unfortunately been mistaken for lead colic, and treated with purgatives. The peritonæum contained a curious mixture of sero-pus and castor oil in large quantities at the time of the operation, from which the patient rallied only to die after three days from profuse hæmorrhage from the ulcer.

Operative Interference in Relapsing Appendicitis.—

On this subject the profession owes its lead and the most instructive of its information to Sir F. Treves, who first proposed the removal of the appendix, during a quiescent period, in 1877, in a paper read before the Medico-Chirurgical Society.*

One or more of the following *conditions*, given by Sir F. Treves, will be accepted by all as *justifying operation*:—(1) The attacks have been very numerous. (2) They are increasing in frequency. (3) The last has been so severe as to place the patient's life in considerable danger. (4) The constant relapses have reduced the patient to the condition of a chronic invalid, and rendered him unfit to follow any occupation. (5) Owing to the persistence of certain local symptoms during the quiescent period, there is a probability that a collection of pus exists in or about the appendix.

* The most valuable contributions of this surgeon are his *Treatment of Typhlitis*, 1888 and 1889; *Brit. Med. Journ.*, vol. i. 1893, p. 835, and vol. i. 1895, p. 517. In America, Dr. H. Mynter, following on the lines of the late Dr. G. Buck, was one of the earliest to advocate operative steps in certain cases of appendicitis, especially those accompanied by perforation (*Buffalo Med. Journ.*, 1879, p. 122).

I would go further and advise operation after the first genuine attack of appendicitis, for who is to say that a second seizure may not be fatal? There is little doubt but that the safest course for the individual is to have his appendix removed after one undoubted attack, for one attack predisposes to another, and the mortality of the interval operation by capable and aseptic surgeons is under 5 per cent.

Some surgeons and more physicians do not advise operation until after the second attack.

Operation.—This is performed on the same lines as those given at p. 297. The details will vary with each case.

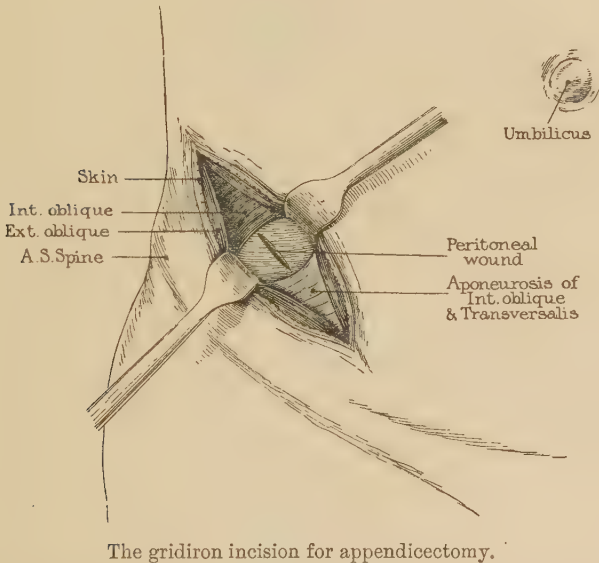
"Some of the cases have been most trifling. On the other hand, in two instances I failed to remove the appendix after very persistent attempts. It is impossible to predict beforehand the features of the operation. The attacks may have been violent and numerous, and the removal of the diseased process nevertheless prove to be a mere trifle. On the contrary, some of the most difficult operations I have met with have been cases in which I had hoped, from the history of the attacks, to have encountered no complications" (Treves).

The skin having been carefully cleansed, an oblique incision is made about four inches long and crossing McBurney's line* about an inch and a half above the anterior superior spine. The aponeurosis of the external oblique is divided in the direction of its fibres, which practically corresponds to the line of the skin incision, the small piece of external oblique muscle being split, also in the direction of its fibres. The internal oblique and transversalis muscles, which run in a direction almost at right angles to that of the skin incision, are now likewise split in the direction of their fibres and well retracted. By making the abdominal incision in this way, as described by McBurney (*Ann. of Surg.*, vol. xx. p. 38), the weakening of the abdominal wall which necessarily results from free transverse division of muscular fibres is avoided, and the tendency to subsequent ventral hernia thereby greatly diminished. Although the amount of room obtained to work in by this method is somewhat lessened, and the difficulty of the operation to some extent increased, the advantage gained is so distinct that it should be adopted wherever possible, and more room can be obtained by opening the rectus sheath and retracting the muscle, as advocated by Harrington and Weir (*loc. cit.*), and more recently by Major Holt (*Lancet*, vol. i. 1905, p. 640). Dr. G. G. Davis (*Ann. of Surg.*, vol. i. 1906, p. 106) has introduced a transverse incision one and a half inches long with its centre over the semilunar line at the level of the anterior superior spine. The rectus sheath is opened and the muscle retracted inwards. In difficult and in suppurative cases, the incision can be prolonged outwards as far as the anterior spine and inwards nearly to the linea alba. The centre of the incision is over the usual position of the base of the appendix. In suppurative cases drainage can be used near the ileum, the rest of the wound being closed. This incision is said to give a better access than the gridiron one, and also not to increase the risk of hernia, because only the external oblique fibres are cut across, the fibres of the deep muscles being separated. It certainly gives a better approach to the retro-cæcal appendix than that given by the rectus incision. The greatest

* This may have to be modified according to the position of any swelling.

care must now be exercised, as the cæcum may be adherent to the peritonæum. If any difficulty is experienced the incision should be prolonged until it is certain that the peritonæal sac is opened. Any omentum that is present, adherent or thickened, should be removed. The appendix is now identified. This may be easy or difficult, from the structure being embedded in adhesions, lying under a cæcum itself fixed by adhesions, or tied down in one of the loculi which Mr. Lockwood has described. When it is found, its removal may be rendered difficult or impossible by the density of its adhesions, or by the important structures which these have implicated. Thus, Sir F. Treves, in the 32 cases which he published, found it adherent to the ureter, internal iliac artery, bladder, and ileum. I found one appendix closely attached low down to the anterior wall of the rectum into which

FIG. 86.



an abscess had discharged, and another recently operated upon was tucked up between the liver and the diaphragm just in front of and to the right of the gall-bladder.

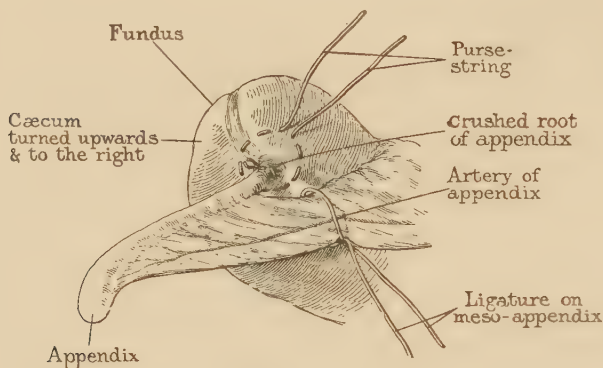
The following, one of the two cases in which Sir F. Treves found it impossible to remove the appendix, gives a good idea of the difficulties which may be present.

"For a considerable time I was unable to demonstrate the abdominal cavity, owing to the adhesions. The cæcum was completely buried in a dense mass of adhesions, and here was hidden, no doubt, the appendix. I was not disposed to undertake the serious risk of opening up this area, especially as the adhesions obliterated both the ureter and the iliac veins, structures in no little risk of being wounded in these operations." The patient remained free from attacks up to the date of the case being published, six months after the operation.

When the area in which the surgeon is going to find or separate the appendix is defined, it should be shut off with aseptic gauze tampons

or flat sponges. Where possible, adhesions should be cut with blunt-pointed scissors; where soft, or where the surgeon is in doubt as to their nature, they must be very carefully torn through with a fine-pointed blunt dissector. Where this separation of adhesions has opened

FIG. 87.

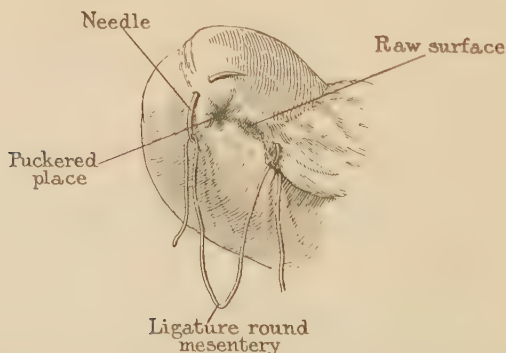


The removal of the appendix.

The mesentery is transfixed and tied close to the root of the appendix; the latter is crushed, tied, and then inverted by the pursestring suture previously inserted.

the cæcum or ileum, these must be carefully closed with Lembert's sutures (p. 353). Where it is quite impossible to separate the appendix from such structures as the bladder, iliac vessels, ileum, &c., Sir F. Treves recommends division of the appendix as near to the cæcum as is

FIG. 88.



The stump of the meso-appendix is made to cover the site of the inversion.

safe, and then paring down the part adherent to the dangerous viscus until it is reduced to a mere disc. The actual removal of the appendix is carried out by one of the different methods given at p. 300. I transfix and tie the mesentery and crush the appendix close to the cæcum so

as to break the muscular and mucous coats and arrest hæmorrhage (Doyen). The roof is then divided and inverted by means of a pursestring suture previously inserted in the outer layers of the cæcum. It is not necessary to ligate the stump. The meso-appendix is then used to cover the site of inversion (*vide* Figs. 87, 88).

Eastman (*Journ. Amer. Med. Assoc.*, Oct. 11, 1902) prefers to remove the appendix by means of the cautery, and to facilitate this he has invented a pair of forceps provided with non-conducting shields to protect the cæcum. The sterilised stump is inverted by means of Lembert or pursestring sutures.

Kelly (*Amer. Med.*, Dec. 31, 1904) uses a pair of powerful crushing forceps, which he applies to the base of the appendix. He divides the latter with the cautery, and then inverts the stump. A pair of ordinary pressure forceps is applied to prevent leakage of the contents of the appendix. Reidel (*Zeit. f. Chir.*, 1903, No. 51) criticises other methods, especially the cuff amputation. He advocates division between two catgut ligatures, excision of the mucous membrane of the stump, suture of the serous and muscular coats, removal of the basal ligature, and inversion of the stump by means of one or more rows of sutures.

Zeller's plan (*ibid.*, 1903, No. 45) of removing a part of the cæcal wall as well as the appendix is not to be recommended.

Ries (*New York Med. Journ.*, July, 1903) inverts the stump within the cæcum, not being content with merely burying it in the cæcal wall, lest an abscess form and give rise to further trouble. The invagination is accomplished by means of a fine needle carrying a thread which has a large knot at one end. The needle first pierces the appendix from within outwards, then back again at a distance of one-sixteenth of an inch from the base, and into the cæcum. It is then brought out through the cæcal wall about an inch from the stump, which is inverted by pulling upon the string, and retained in this position by means of sero-muscular sutures passed through the orifice of the funnel. The thread is then cut short and allowed to retract into the bowel, and the mesenteric stump is sewn over the site of the former stump. The cæcal suture may carry infection into or through the wall of the bowel.

Most of these methods are unnecessarily elaborate, and some of them require special instruments, which may not be available. Whatever method is used, the appendix must be removed quite close to the cæcum to prevent the possibility of recurrence of symptoms from retention within a stump (Treves, *loc. cit.*). The cautery has the advantages of thoroughly sterilising the stump and preventing primary hæmorrhage from it, but it may lead to sloughing unless used with care. Reidel's method is a good one, which can be simplified and improved by use of a pursestring suture for the inversion.

When any area has been unavoidably denuded of its peritonæal covering, the edges of this must as far as possible be drawn together, or an omental flap applied. If the part is intestine and weakened, gauze strips should be used to shut it off and drain it. If there is free and persistent oozing as the result of separation of adhesions, a gauze tampon should be packed down on to the bleeding surface and left in place for twenty-four hours; the need for this should be rare.

To minimise, as far as possible, the risk of hernia, especially in young subjects with an active life before them, the wound in the abdominal wall should be carefully sutured. The peritonæum, internal oblique and transversalis, the aponeurosis of the external oblique, each of these three layers, should be united with a separate row of buried sutures of chromic gut, and then the skin with horsehair. If drainage has been employed, provisional sutures should be placed.

Mortality.—This is very small at the present day. Thus Murphy (*Amer. Journ. Med. Sci.*, August, 1904) states that about two-thirds of

his 2,000 operations were performed in their quiescent stage, and that of these only one died. The cause of death was peritonitis.

G. R. Turner (*Lancet*, vol. i. 1905, p. 643) states that the recent statistics of five London hospitals show a mortality of '5 per cent.

Pearce Gould (*loc. cit.*, p. 569) reported 214 interval operations, with three deaths.

Lynn Thomas (*Lancet*, vol. ii. 1905, p. 753) records 129 operations performed in the "interval," with no death.

Complications of Appendicitis.—Owing to the frequency of the disease and of operations for it, it will be well to bear in mind the chief complications which may accompany the severer cases, and operations for their relief. A mere enumeration must suffice. (1) Intestinal obstruction. This may be due (*a*) to paralysis of the intestines from septic peritonitis; (*b*) to adhesions about the appendix; (*c*) to its becoming adherent to some piece of intestine, mesentery, &c., and so incarcerating and strangling a loop of bowel. (2) Fistula.* This may be (*a*) mucous, or (*b*) fæcal. It may be due to incomplete closure of the appendix, to the leaving behind of a stercolith, or especially to giving way of the cæcum or ileum. (3) Hepatic abscess. (4) Empyema, or (5) purulent pericarditis. Dr. Fowler shows (*loc. supra cit.*) that pus in the liver will tend to involve the diaphragm, and so bring about the last two conditions. I should have thought a simpler explanation was a collection burrowing upwards along the psoas. I have had one such case of right-sided empyema. The patient, aged 53, made a good, though very slow, recovery, chiefly due to the devoted attention of his dresser, Mr. Anderson. (6) Suppuration in the loin and about the kidney. (7) Suppuration in the pelvis. An exceptionally long appendix may dip into the pelvis and bring about the above. A case of this kind is given by Fowler. It was successfully treated by abdominal section. (8) Phlebitis of iliac veins. Fowler gives a case in which the appendicitis, being gangrenous, brought about ulceration and fatal hæmorrhage. (9) Appendicitis in a hernial sac. Fowler mentions a case reported by Dr. Rand, of Brooklyn, in which an irreducible femoral hernia became the site of inflammation due to an inflamed appendix which it contained. Sir F. Treves met with a case in which the appendix, the seat of recurrent trouble, occupied an inguinal sac. (10) Communication with the rectum, bladder, or vagina. (11) Septicæmia. This may supervene, as on one of the last-mentioned complications, quite apart from suppurative peritonitis. (12) Abscess in the abdominal wall, causing most extensive burrowing. (13) Stitch sinus. (14) Ventral hernia. (15) Thrombosis of the femoral vein, especially the left one. Dr. Meyer describes two cases of this (*Ann. of Surg.*, May, 1901).

Mr. Lett (*Medico-Chir. Trans.*, 1905, and *Lancet*, vol. i. 1905, p. 569) records the complications of 1,000 operations for appendicitis as follows:—Fæcal fistula, 49; thrombosis of the femoral vein, 12; intestinal obstruction, 10; broncho-pneumonia, 17; pleurisy with

* Treves' *Surgical Treatment of Typhlitis*, p. 45. Mr. Southam has published (*Lancet*, vol. ii. 1892, p. 835) a case successfully treated by short-circuiting the intestine. Senn's plates were used.

effusion, 14; pleurisy without effusion, 2; empyema, 7; acute bronchitis, 4; pulmonary embolism, 1; parotitis, 4; pylephlebitis, 4; residual abscess, 11; secondary abscess, 12.

Failure of the Operation to give Relief.—Mr. Lett (*loc. cit.*) found that 11 out of 231 patients complained of attacks similar to those which occurred before the operation.

Sir Frederick Treves (*loc. supra cit.*), in 45 patients imperfectly relieved, found that the appendix had not been completely removed in 2, ovarian disease in 9, colitis in 8, local pain in 7, neurasthenia in 5, gallstones in 3, movable kidney in 2, renal calculus in 1, tender mass in the iliac fossa in 5.

INFLAMMATION OF MECKEL'S DIVERTICULUM.

This may closely simulate appendicitis and intestinal obstruction, and may result in (a) simple catarrhal inflammation without infection of the peritonæum; (b) formation of a localised abscess; or (c) perforation or gangrene leading to diffuse suppurative peritonitis, which is relatively more common and more fatal than the peritonitis arising from the vermiform appendix. The cause of the trouble is not diagnosed before an operation is undertaken for the relief of intestinal obstruction or for the treatment of peritonitis, generally considered to be of appendicular origin. This condition is more fatal than appendicitis for several reasons: the greater size and larger lumen of the diverticulum favour fæcal extravasation from a perforation; the greater freedom and more median position of this unusual appendage are also unfortunate for localisation of inflammatory products and extravasations arising from it; and, lastly, intestinal obstruction often co-exists, and a kink or volvulus at the base of the diverticulum may cause obstruction of both it and the small intestine at the same time. A gangrenous or perforative inflammation of the obstructed diverticulum is likely to occur and to lead to peritonitis in a few hours.

Gibbon (*Amer. Journ. Med. Sci.*, November, 1903), Clinton (*Buffalo Med. Journ.*, June, 1904), Dineur (*Journ. Med. de Bruxelles*, Nov. 5, 1903), Oliver Ashe (*Lancet*, Aug. 29, 1903), Roberts (*Ann. of Surg.*, July, 1906), Oliver Smith (*Ann. of Surg.*, 1904, vol. xl. p. 744), and others record interesting cases of this kind. Smith quotes Blanc's thesis to the effect that of 12 cases of acute inflammatory and perforative diseases of the diverticulum eight died and three recovered after operation, the result being uncertain in the other cases.

Halstead (*Med. Record*, Nov. 29, 1902) has related two fatal cases of perforation occurring during the second and fourth weeks of typhoid fever; he also mentions two other fatal cases reported by Galton and Boinet, and he points out that perforation is very likely to occur at the fundus, because the muscular wall may be deficient there. Tuberculous ulceration and perforation may also occur, although it is infinitely rare as compared with inflammation following sudden or chronic obstruction and the formation of fæcal concretions.

The treatment of this rare disease should be carried out along the lines laid down for appendicitis and its complications, for which the operation will have been undertaken as a rule. The diverticulum may be removed and its base inverted by pursestring or Lembert's sutures;

but this may not be always possible, owing to the constriction or twist or gangrene of the small intestine, which may have to be resected or primarily drained and secondarily resected in bad cases with paralytic distension existing or threatening.

PERFORATION OF GASTRIC ULCER.*

The perforation may either be *acute*, associated with sudden escape of gastric contents into the general peritonæal cavity, or *subacute*, resulting in the formation of a localised abscess. It may also be chronic, leading to adhesion of the base of the ulcer to the liver, pancreas, or abdominal wall, any of which may form the base of the ulcer in time.

A. Acute Perforation.—The successful treatment of these most fatal lesions depends upon early operation.

This should be performed as soon as possible after the accident, delay only leading to the additional escape of septic material, especially if the patient is moved about. Another urgent reason for early operation is the fact that the later the operation is deferred, the more difficult it is, and the less is the patient able to bear the shock of the interference. Again, the longer the delay, the greater is the tendency to the formation of masses of lymph, which may conceal the ulcer, mat viscera together, and so form culture-pools for bacteria, and hamper the attempts at cleansing the peritonæum.

While the surgeon will be unwilling to interfere during the period of early collapse which follows on the perforation, he should utilise this time in making the needful preparations.† The serious results of delay are well shown in the following table from Robson and Moynihan's *Diseases of the Stomach* :—

				Total cases.	Recovered.	Died.	Mortality.
Operation under 12 hours	...	...	...	49	35	14	28·5 %
" from 12—24 hours	...	...	...	33	12	21	63·6 %
" " 24—36 "	...	...	...	16	2	14	87·5 %
" " 36—48 "	...	...	...	2	0	2	100·0 %
" over 48 hours	...	...	...	35	16	18	51·5 %

It seems clear that while ulcers occur most frequently on the posterior surface of the stomach, those on the anterior surface are most liable to perforate. Thus, out of 90 cases operated upon, the perforation in 86 was on the anterior surface, posterior perforations occurring only in 11 cases. Perforations are more frequently nearer the lesser than the greater curvature, and the cardia than the pylorus. This last fact is one of much practical importance, as the cardia is a relatively fixed point, and the nearer an ulcer is to this end, the greater is the

* This is placed here instead of under the "Operations on the Stomach," first because, like a perforated vermiform appendix, it is such a dangerous source of peritonitis, secondly because it calls for the same treatment as the less common duodenal ulcer.

† A hot-water table, water-bed, and hot bottles should be provided, the patient's limbs bandaged in cotton-wool, the head kept low, ether given, and an enema of port wine administered; injections of strychnine and the necessaries for saline infusion should also be at hand.

difficulty in suturing it. Finally, it should be remembered that in several cases there have been more than one perforation. Finney (*Ann. of Surg.*, July, 1900) says that in 20 per cent. of the cases there is a second perforation. Gastric and duodenal ulcers sometimes perforate simultaneously.

A warning may be necessary here that a great variety of conditions have been mistaken for perforated gastric ulcer, some of which may be mentioned:—Perforation of duodenal ulcer, ruptured tubal gestation, menstruation, perforative appendicitis, acute hæmorrhagic pancreatitis, thrombosis of superior mesenteric vein, pneumonia, acute poisoning, acute dilatation of the stomach, and acute inflammation of the gall-bladder. It will be noticed that most of these conditions require operative treatment, so that a mistake is only serious as regards the site of the incision and the prognosis that can be given. In others, an operation can do no harm, but may do good; but in pneumonia, pleurisy, menstruation, &c., the confusion of these with perforated gastric ulcer is as serious as the opposite mistake of declining to advise operation for a perforated ulcer. It may therefore be well to emphasise the leading and really important diagnostic features of perforation of a gastric ulcer. Too much stress cannot be laid on the history, which is almost constant, of *a sudden onset of dreadful and intolerable pain, especially in the epigastrium*, and later becoming general and even pelvic from trickling down of the escaping fluids. A sensation of something giving way is often mentioned by the patient. *Shock of a severe degree* soon follows, and is very characteristic when seen, but the patient is often better when the doctor arrives. *A contracted, rigid, tender abdomen*. Later, of course, it will be full and tympanitic. The respirations are shallow, catchy, and hurried, hence the mistake of diagnosing pneumonia in some cases. *Vomiting* occurs in about half the cases, and about 80 per cent. give a history of indigestion or more serious gastric troubles (Robson and Moynihan).

The operation itself includes: i. Finding the perforation; ii. Successfully closing it; iii. Efficiently cleansing and draining the peritonæal sac—headings which will be taken separately.

Operation.—The parts having been fitly cleansed, and every precaution taken against shock, an incision four to five inches long is made from near the left costo-xiphoid angle to the level of the umbilicus and through the rectus sheath. The falciform ligament is thus avoided. When the peritonæum is opened an escape of gas is not uncommon,* sometimes of fluid, consisting partly of the last meal taken,† and partly of serous effusion from the irritation of the peritonæum.

If there is no such escape the outlook is so far more favourable, as it may be hoped that as yet the effusion is slight, and limited to part only

* If it is a late case, as in one I mention (p. 321), the tympanites and distended intestines may be most embarrassing. In one published by Dr. Anson (*Lancet*, vol. i. 1893, p. 469), the distension all subsided after a rush of odourless gas when the abdomen was opened.

† The interval that has elapsed is most important. Thus in a successful case published by Dr. Walter, of Reading (*Lancet*, vol. i. 1895, p. 484), five hours had elapsed. So, too, in a case of Dr. W. Hall's (*Brit. Med. Journ.*, vol. i. 1892, p. 64) which recovered without operation after very severe peritonitis, the interval was four hours.

of the peritonæal sac. If this be so, though it is uncommon, the surgeon should shut off the lower part of this sac as far as possible with gauze tampons or flat sponges before he disturbs the stomach and its surroundings.

i. **Finding the Perforation.**—This varies very much in difficulty. Sometimes the eye detects it at once when the stomach is drawn downwards and to the right and the edges of the wound well retracted, the left costal arch being pulled upwards, forwards, and outwards. At other times the exploring finger soon feels it or the area of induration which forms the base of the ulcer. In other cases finding the ulcer is beset with the greatest difficulty, or, owing to the hurried search which alone is possible from the state of the patient, is quite impossible. In a difficult case help may be obtained by tracing the direction in which the congestion of the stomach appears to be increasing, by watching the direction from which any flow that may be present is coming. A suggestion has been made to inject air through an œsophageal tube so that the escaping bubbles may lead to the ulcer. The liver should be raised by an assistant, and the stomach drawn downwards and to the right, while the whole of the anterior surface and the lesser curvature are carefully examined with a good light. Adherent lymph or adhesions between the stomach and liver may mark the site of the perforation, and require gentle separation before it is revealed. The perforation itself may be extremely small, and thus easily hidden by any fold of the stomach, still more readily by lymph and adhesions.

Mr. Dunn's case (*loc. infra cit.*) well shows how difficulty here is to be met :

On separating the adhesions which fixed the liver to the abdominal wall, a quantity of opalescent fluid escaped. The liver was then pulled upwards and the anterior wall of the stomach pushed backwards, and now it was that some brownish fluid like weak coffee, containing gas-bubbles and one or two small masses of coagulated milk, escaped. It welled up from a considerable depth, at the left of the incision, and was found, on subsequent examination, to be strongly acid, and to contain a little albumen. Several more adhesions were broken down, but still no perforation could be seen, and it was only when the left margin of the wound was stretched outwards to the utmost, whilst steady traction was made upon the stomach towards the right, that the hole in this viscus became visible.

At this stage, or a little later, to facilitate the suturing, it may be necessary to divide the left rectus, in order to get more room. Save for weakening the abdominal wall, this step is a light one, as long as the intestines are not distended. If distension is present it is a serious complication, as it facilitates very much the escape of the intestines.

ii. **Closure of the Perforation.**—It has been suggested that, before this is done, the stomach should be emptied and washed out. If the perforation has been quickly found, if the patient's condition is good, and if the stomach can be got well outside the wound, emptying by gentle squeezing will be beneficial, by preventing vomiting, and thus a strain on the sutures. So, too, with regard to washing out the viscus, if a drainage-tube can be readily inserted through the perforation. But the small size of the external opening will often prevent this ; and, with regard both to emptying and washing out the stomach, it

is certain that in neither case will the advantages gained counter-balance the loss of time, that would have been better spent later on, in thoroughly washing out the peritonæal cavity.

With regard to *excising the ulcer*, which has been recommended, the same conditions and objections apply. Much extra time will be consumed, there may be a good deal of additional hæmorrhage, and the perforation may be converted into a large gap requiring numerous sutures to close it (Swain, *Lancet*, vol. ii. 1894, p. 22). In this case much difficulty was met in inverting the pouting mucous coat. Moreover, the successful cases treated by suture without excision show that this step is not needful. St. Clair White (*Brit. Med. Journ.*, Feb. 20, 1904) reports five consecutive cases in which the ulcer was excised and the aperture closed with two layers of sutures, fortified by an omental graft. Two of these cases died some time later as a result of ulceration at the line of suture. One died a fortnight after the operation from profuse and repeated hæmatemesis. The other death, which occurred after six weeks, was due to a small abscess in the stomach and secondary multiple hepatic abscesses.

Mr. Mothersole (*Lancet*, vol. ii. 1905, p. 223) records two cases in which he successfully excised the ulcers near the pylorus, and in each case he sutured the wound in such a way as to widen the pylorus. About four months later the patients were quite well. Mr. Mitchell (*Brit. Med. Journ.*, 1905, vol. ii. p. 779) and Mr. Anderson (*Lancet*, 1905, vol. ii. p. 944) found that excision of the ulcer did not give permanent relief, however. In Mr. Anderson's patient, symptoms of ulceration returned after a year, and gastrojejunostomy had to be performed after sixteen months; this gave complete relief. If the perforation is spilling its contents when seen, a finger or sponge in a holder should be placed upon it, or a silk suture passed across its centre so as to prevent further escape. The perforation having been shut off with iodoform gauze tampons, it is next carefully closed with Lembert's sutures of sterilised silk.* One row of these will suffice if inserted with the following precautions: They should begin and end well beyond the extremities of the perforation (Fig. 353). They should take up the coats of the stomach as far as, but not beyond, the sub-mucous layer. When the ulcer is near the pylorus the sutures should be passed from side to side and not from above downwards, to avoid narrowing of the outlet of the stomach. Fortunately, it is also easier to pass the sutures in this direction than from above downwards. They should be inserted far enough from the margins of the perforation to ensure sufficient inversion of the serous surfaces when the sutures are tightened, and this inversion may be aided by a probe or director. All the sutures should be inserted before any are tied. If any cut out as they are fastened, fresh ones must be reinserted at a sufficient distance from the margins of the perforation to give a firm hold, and a second set must be employed where the union is certainly weak. For small perforations a continuous Lembert suture may be used, and this is a very rapid way of closing the hole; a pursestring suture may also serve, but it is apt to tear out.

* The passage of these may be facilitated by the use of two guide-stitches of medium-sized silk, passed a full inch from the edges of the perforation, as used by Mr. Gould in his case.

Whenever it is feasible the suturing should be performed with the viscus outside the wound, this part of the stomach resting on hot tampons of sterile gauze.* When it is not possible to bring the stomach outside, the difficulties are greatly increased, especially if the perforation be near the cardia, a more fixed part. Here drawing up the margin of the ribs and liver, pulling down the stomach, or division of the left rectus may be of service.

Where either the position of the ulcer or the amount of surrounding induration makes it impossible to close a perforation with sutures, one of the following courses should be followed: (1) A piece of omentum may be used to close the opening, being kept in position by means of careful suturing. (2) If the ulcer lies under cover of the liver it may be possible to fix this down, over the perforation, by means of sutures. (3) A cigarette drain may be inserted near the perforation and removed after thirty-six hours. (4) A posterior gastrojejunostomy may be performed, for by this means leakage may be greatly diminished, if not prevented. Anterior gastrojejunostomy was first performed for this condition by Braun (*Centralblatt für Chirurgie*, Leipsic, 1897, p. 739). The patient recovered, and remained well for several years.

Mr. Paterson (*loc. cit.*) considers that drainage by means of the anterior operation deserves a thorough and extended trial as a routine treatment of perforated gastric ulcer. He maintains that this may prevent subsequent troubles from persistence of ulceration, hæmorrhage, secondary perforation of the same or of another ulcer. He also states that a more thorough closure of pyloric ulcers will be possible without risk of stenosis, that the rest given to the stomach promotes healing of the perforation, and that earlier feeding and administration of purgatives can be allowed. He also quotes Finney that in 20 per cent. of the cases perforations are multiple, and that gastrojejunostomy may save these cases even if a perforation be missed. The most important and to my mind sufficient objection is that these patients are rarely in a condition to stand a prolongation of the operation when they come for treatment. If a gastrojejunostomy becomes necessary it is safer in the great majority of cases to do it at a second operation. In some very early, and especially in pyloric or duodenal cases, a gastrojejunostomy may be primarily performed. Dr. Herbert French (*Med.-Chir. Trans.*, November, 1906) was able to trace and examine 18 out of 30 Guy's Hospital patients who had recovered after operations for perforated gastric ulcers. Fifteen of these patients were wonderfully well in every way, but the three others had abdominal symptoms of various degrees of severity. When such symptoms arise a secondary gastrojejunostomy may be recommended, although it is not certain that the operation will give relief, for the symptoms may be due to adhesions, in some cases at least.

Mr. Crisp Inglis (*Med.-Chir. Trans.*, 1903, vol. lxxxvii.) found that only four out of 15 cases had any gastric symptoms following the

* Whenever during an abdominal section it is necessary to keep viscera outside, it should be the duty of one assistant to see that their temperature is maintained and that their surroundings are aseptic only, and it should be the duty of a separate nurse to help in this.

operation of closing the ulcer. These patients had symptoms of dyspepsia, for which two were readmitted into St. George's Hospital.

Mr. Paterson (*loc. cit.*) traced 33 cases, and found that 16 were quite well, but that 17 suffered from gastric symptoms, and 1 of them died of a secondary perforation; 2 required gastrojejunostomy as a secondary operation, and 9 had symptoms of gastric ulcer, and 5 suffered from dyspepsia. In two other cases, for which a primary gastrojejunostomy had been performed, no symptoms were complained of within fifteen months and two years.

Paterson states that in 112 cases collected from the statistics of two London hospitals there were 13 deaths which might possibly have been prevented by a primary gastrojejunostomy: 3 died from hæmorrhage; in 8 the sutures closing the ulcer gave way, and this led to secondary extravasation and death; and 2 died because a second perforation remained undiscovered in each of them.

Mr. Moynihan has performed gastrojejunostomy in 6 of these cases of perforated gastric ulcer, with 5 recoveries (*Med.-Chir. Trans.*, November, 1906).

So far I have spoken of *ulcers on the anterior surface of the stomach*. The rarer but much less accessible ones on the *posterior* surface must now be referred to. As is well known, while gastric ulcers are much more frequently met with on this surface, these rarely perforate, owing to the tendency for adhesions to form between this surface of the stomach and the pancreas. If the evidence of perforation is strong, and nothing can be found on the anterior surface or lesser curvature the surgeon can examine the posterior wall (a) by carefully tearing through the lesser omentum and inverting the anterior wall: the posterior one comes into view through the hole made in the lesser omentum*; (b) by tearing through the great omentum; (c) by passing the finger through the foramen of Winslow. In five out of 42 cases reported by Crisp Inglis the perforation was on the posterior wall close to the pylorus (*Medico-Chir. Trans.*, 1903, vol. lxxxvii.). In 10 per cent. of the 112 cases collected by Paterson the ulcers were on the posterior surface of the stomach.

In a case, under the care of Dr. L. E. Shaw, I adopted the first of the above plans. The operation was performed seventeen hours after the perforation. As no perforation could be found on the anterior surface of the stomach, the lesser omentum was carefully torn through and the posterior surface explored. A small, recent-looking ulcer was found near the lesser curvature, with a small perforation in its centre. With considerable difficulty six Lembert's sutures were inserted so as to invert the ulcer. Irrigation was not performed, but free drainage was employed, a Keith's tube being placed in the pelvis, and a tube and gauze strips passed down to the lesser curvature. The patient made a good recovery.

iii. **Cleansing of the Peritonæal Sac.**—Though most stress has been laid upon the point of efficient suturing of the perforation, there is no doubt that this one is quite as important. Irrigation is indicated in most cases of perforated gastric ulcer, because of the extensive degree

* Mr. J. R. Morrison, of Newcastle, adopted this plan (*Brit. Med. Journ.*, vol. ii. 1894, p. 864). The patient survived till the ninth day, and at the necropsy the peritonitis was limited to the pelvis.

of the extravasation of the stomach contents. Irrigation is probably better than other ways of removing this foreign material, and creates less disturbance and shock than extensive mopping would require. The fluid used should be boiled water or saline infusion, *e.g.*, sod. chlor. 3j.—Oj. of boiled water at a temperature of 105°. If no irrigator is at hand a glass tube or the end of an œsophagus-tube, attached to india-rubber tubing (all having been sterilised) and arranged as a syphon or attached to a funnel, will answer very well. Failing this, a clean Higginson's syringe will suffice, if some one else pumps in the fluid so as to set free both the surgeon's hands for the delivery and distribution of the fluid. The cleansing must be systematic, persevering, and thorough. The whole cavity must be gone over in a regular way, and there is no better method than that given by Dr. Maclaren, who has operated in three cases, in one with success (*Brit. Med. Journ.*, vol. ii. 1894):

"The plan I take is to begin with the neighbourhood of the rupture, wash it well, then starting from this as a centre, to make the nozzle follow the course of the colon, first towards the cæcum, specially cleaning out below the liver; secondly, starting again from the stomach, to follow the great bowel to the rectum. In this latter course the lumbar and pelvic hollows should receive special care. Finally, the douche is directed among the folds of the mesenteric attachments of the small intestines. I have repeatedly noticed here, when all seemed clear, that a fresh turn of the instrument would empty some unsuspected pocket."

It is an advantage to make a small wound about two inches above the pubis, care being first taken to ascertain that the bladder is empty. This plan facilitates the irrigation, and a tube can be passed through the puncture and the irrigation carried on throughout the greater part of the operation.

If the extravasation is limited, as it may be in very early cases, it is wiser not to irrigate, as this may do more harm than good. The soiled portion of the peritonæum should be carefully cleansed with soft mops of sterilised gauze, care being taken, on the one hand, to cleanse the parts as thoroughly as possible, and, on the other hand, to avoid damage to the peritonæum by using undue force.

Some surgeons prefer to trust entirely to mopping in this way without using irrigation at all, for instance Mr. Barker (*Clin. Soc. Trans.*, 1900), who gives a list of 12 cases treated by mopping alone, with five recoveries. Mr. Paterson (*Lancet*, vol. i. 1906, p. 574) in his Hunterian lecture does not recommend irrigation, because he believes that it increases shock, but this is not the experience of most surgeons. It would seem, however, wiser on the whole to irrigate thoroughly when the general peritonæal cavity is contaminated, supplementing this, if necessary, with careful wiping to get rid of any coarser particles that may be visible, and to trust entirely to wiping only when the extravasation is localised. It is not easy to tell the extent of the soiling, and it is wise to examine the kidney pouch in every case. Before closing the abdominal wound the question of drainage will arise. The necessity for this largely depends upon the particular conditions found at the operation. If the case has been operated upon quite early, if the amount of extravasation is small and limited, and the area thoroughly

cleansed, the abdominal wound may be closed without drainage. In the great majority of cases, however, drainage will be necessary. Usually gauze drains passing in various directions from the abdominal incision will meet all requirements: one should pass down to the seat of perforation; another upwards between the stomach, liver, and gall-bladder; and another downwards beneath the abdominal wall towards the umbilicus. Others may be added if thought advisable. If extensive extravasation implicating practically the whole abdominal cavity has taken place, a tube should be passed down into the pelvis through a small incision above the pubes, in addition to the gauze drains. The semi-sitting attitude should be adopted as soon as the patient is round from the anæsthetic, to promote drainage and to lessen the risk of pulmonary complications and sub-diaphragmatic abscess. Shock should be treated as already described at p. 305.

Rectal feeding must be employed for at least forty-eight hours, nothing being given by the mouth during this time save sips of tepid water. It will be well to watch these cases for a long time after. Thus, Mr. Silcock reports a case treated successfully by drainage, the ulcer not being found: the patient "has suffered since from impaired locomotion of the stomach, and has been from time to time under treatment as an out- or in-patient."

Causes of Failure.—In every new operation especially it is well to bear these in mind. The chief are: (1) Peritonitis existing before, and not removed by, the operation. This has been the most frequent cause of death. It was so in two cases on which I operated. Both were under the care of Dr. Newton Pitt:

In the first the symptoms of shock and peritonitis were distinctly subacute and slightly marked. My colleague, however, was sure of his diagnosis, and when the abdomen was opened an open ulcer was easily seen on the anterior surface, from which a greyish liquid was continuously gushing. On bringing the perforation outside the abdomen, the opening was felt to be surrounded by a large callous base. Death took place from peritonitis forty-eight hours later; at the necropsy the ulcer was found firmly sutured. In the second case operation was refused at first when urged upon the patient, and it was not until the third day, when the abdomen was greatly distended, tympanitic, and motionless, that the patient and her friends, seeing how hopeless the case was getting, gave their consent. When the abdomen was opened the stomach itself was greatly distended. The peritonæal sac, especially at its upper part under the liver, between this and colon, spleen, and kidneys, was filled with purulent fluid, in which the more solid part of the last meal taken (Scotch broth) could be seen floating. All the viscera seen were thickly scattered with thick yellowish flaky lymph. This was especially present, together with numerous soft adhesions, between the lesser curvature and the liver. Had I broken down and searched amongst these I should have found the ulcer,* but the anterior surface being sound, and the stomach greatly distended, I examined the duodenum and found, as I thought, a minute perforation, a softened spot on the anterior and inner part of the first portion, into which a probe passed. This I sutured, and sponged and washed out the peritonæal sac. The patient was in a most critical state at the time of the operation, and sank thirty-eight hours after. At the necropsy a perforation was found on the lesser curvature.

The surgeon fortunately gets his opportunity earlier now than he did a few years ago, and naturally the risk of death from peritonitis in

* No surgeon should leave these unexplored in the hope of a natural cure. This, if accomplished, will very likely be so at the cost of a sub-phrenic abscess and septicæmia. See also the remarks above.

spite of an operation is considerably diminished. Two recent cases came under the care of one of us (R. P. R.), one within five hours and the other after nine hours from the onset of acute symptoms.

The first case was that of a young man of 23 who was walking home hungry over the Tower Bridge when he was suddenly seized with such a severe pain in his abdomen that he was obliged to lie down on the pavement. He was promptly brought up in a collapsed condition to Guy's Hospital. His condition soon improved, however, and then he refused operation because he could not be persuaded of his peril. He wished to consult his mother first, but she lived far away. At last he consented, when his condition was compared with that of a drowning man, who declined to grasp a rope until he had obtained his mother's sanction. The patient gave a history of an attack of appendicitis. The pain, tenderness, and rigidity in the present illness was more marked on the right side near the appendix, and there was impaired resonance in the right loin. An incision was made through the right rectus at a higher level than is adopted for appendicular cases, because it was felt that the very sudden and severe onset was very suggestive of perforation of the stomach. Sero pus was found in the iliac fossa, but the appendix was not actively diseased; the incision was enlarged upwards, and a good-sized round perforation was found and closed with Lembert sutures. On account of the extensive extravasation, free irrigation was employed, followed by the insertion of cigarette drains, one between the stomach and the liver, and another in the right kidney pouch. The patient was quite well nine months later.

The second patient was a girl of 19, who had suffered severely from indigestion for six months. She also gave a history of a sudden and agonising pain, but it was situated chiefly in the left hypochondrium. She was given a dose of morphia to enable her to travel in comparative comfort from a fever hospital to Guy's. An incision made through the right rectus as high up as possible disclosed a collection of sero pus and gastric contents between the liver and the stomach and also travelling down towards the left kidney pouch. A perforation was discovered on the anterior surface close to the lesser curvature, very near the cardiac orifice. The stomach was drawn downwards and to the right, and an assistant held the left costal margin upwards, while another retracted the liver; and after much trouble the perforation was closed by inversion, and a loose flap of fatty lesser omentum was turned down and secured over the sutures. The ulcer was a chronic one of large size and thick walls, so that inversion was not easy, apart from the depth. Irrigation was not adopted because the extent of extravasation was not great, and dry swabbing was used instead. A cigarette drain was left in front of the stomach near the perforation. The patient recovered.

A third case was that of an old man of 62, who was admitted into Guy's Hospital over forty-eight hours after the perforation had occurred, and after a long journey by train. He had general suppurative peritonitis with tympanitis. The peritoneum was rapidly cleansed by dry mopping, and the ulcer, which was near the pylorus, was closed by inversion with a continuous Lembert's suture. Cigarette drains were placed, one near the perforation and another in the pelvis. The operation only took twenty minutes, and the patient stood it very well, but he died three days later, after seeming to do well for two days. He occasionally brought up some black vomit (altered blood), however. At the autopsy there was no collection of pus in the peritoneum; two acute ulcers were found, one on the posterior wall, which was not perforated, and the other on the anterior wall, which had been satisfactorily closed at the operation.

(2) Shock of the operation and anæsthetic. This can be largely prevented by quick operating and by adopting the other precautions mentioned at p. 305. Soon after the operation infusion is often of great use.

(3) Abscess between the stomach and liver causing septicæmia or leading to empyema.

The treatment must be efficient drainage; an incision being made in front, in the middle line or over any epigastric prominence. Drainage should also be afforded behind

by resection of one or more ribs (*Lancet*, vol. i. 1893, p. 145), or a glass drainage-tube be employed as in a case of Dr. Ewart and Mr. Bennett's (*Lancet*, vol. ii. 1894, p. 1147) *Vide* also chronic perforation, p. 324.

(4) A second perforation. This is stated by Finney (*loc. supra cit.*) to be present in 20 per cent. of the cases, and a careful search should therefore always be made for a second ulcer. Again, a second perforation may take place after the operation, for when the ulcer is very large another spot may give way, probably from softening set up by the local inflammation due to suturing.

Mr. Gould (*Brit. Med. Journ.*, vol. ii. 1894, p. 861) mentions a case of Mr. Pepper's in which a perforation had been sutured. For three days the patient did well, when she suddenly became collapsed and quickly died. The necropsy showed that the perforation which had been sutured was in the front part of an ulcer the size of a crown-piece, the line of suture being perfect and water-tight, but that a second perforation had occurred at its posterior part.

(5) Hæmorrhage from the same or another gastric or from a duodenal ulcer.

B. Sub-acute perforation.—The perforation may be very small or the stomach may be empty at the time of the perforation, so that only a comparatively small extravasation occurs, which may be walled off by adhesions for a time. I operated on a case of this kind under considerable difficulties with Dr. Gardiner at Dunmow. The perforation had occurred about forty-eight hours before the operation, at which a collection of pus was found between the liver, the anterior surface of the stomach, the abdominal wall and the upper half of the great omentum. A small perforation was found near the pylorus; this was closed and the pus was mopped up and drainage employed. The patient recovered, and was well a year later.

The Mortality of Perforation of a Gastric Ulcer.—Ten years ago it was a very rare thing for one of these patients to recover; now recoveries are quite common, and so diligently are the successes published that it is quite possible to underestimate the gravity of this serious accident. It must not be forgotten that fatal results are rarely published, although much more might be learnt from them.

Mr. Crisp English, in a valuable paper (*Med.-Chir. Trans.*, 1903, vol. lxxxvii.), published the results of 50 consecutive operations for perforation of gastric and duodenal ulcers. The operations were performed by many surgeons at St. George's Hospital from 1892 to 1903. Out of the 42 cases of gastric perforation, 52 per cent. recovered, only three of the first ten recovered, but six out of seven recovered in 1903.

Mr. Paterson (*loc. supra cit.*) collected 112 consecutive cases from the records of two London Hospitals, with a mortality of 52 per cent.; and through the registrars of twelve London hospitals he found that 58 operations were performed in 1904, with a mortality of 48 per cent.

Mr. Sargent (*St. Thomas's Hospital Reports*, 1904) states that 49 cases were treated by operation at St. Thomas's Hospital up to 1904; 58 per cent. of these recovered after suture and peritonæal lavage. The average time that had elapsed before the successful operations was twenty-three hours, and before the failures 32.6 hours.

There is no doubt that the results are now better than these valuable statistics indicate, for they extend back several years. Earlier recognition by the general practitioner and the surgeon, leading to earlier operation, and improvements in technique have reduced the mortality; and in private practice the mortality is probably lower than amongst the poor, for the patients seek treatment earlier.

Mr. Moynihan (*Med.-Chir. Trans.*, November, 1906) records 27 operations for perforated gastric and duodenal ulcers, with 18 recoveries (66·6 per cent.). In six of these cases gastrojejunostomy was performed immediately after the closure of the perforation, with five recoveries.

T. S. Kirk (*Med. Press*, March 20, 1903) records 11 cases, in 10 of which the operation was performed between a quarter of an hour and ten hours after the perforation, and all recovered. So far four of my five cases have recovered, but these numbers are too few to found evidence upon.

It is probable that the recoveries will soon amount to 65 per cent. in skilful hands.

Mr. G. R. Turner and Mr. Crisp English (*Lancet*, vol. ii. 1904, p. 145) publish nine cases of perforated gastric ulcer with eight recoveries. Very free irrigation and drainage were employed in eight of these cases.

C. Chronic Perforation.—Instead of sudden perforation, with escape of the contents of the stomach into the general peritonæal cavity, the perforation here is associated with the formation of adhesions and the production of a localised abscess. This may be brought about in several ways. In some cases the base of the ulcer becomes adherent to a viscus—liver, spleen, or pancreas,—subsequent perforation giving rise to an abscess which slowly burrows first into and then beyond the viscus involved. In other cases, the perforation is preceded by a plastic peritonitis resulting in the formation of adhesions, which thus limit the diffusion of gastric contents when perforation occurs. Again, the leakage of gastric contents may at first only take place quite slowly, owing either to the small size of the perforation, to the stomach being empty at the time, or to the perforation taking place during the night. The abscess so produced is in most instances of the *sub-phrenic* variety, the majority of which are caused by gastric ulcers.

The limits of the abscess vary according to the site of the perforation, as will be understood by reference to the accompanying illustrations. Fig. 89 shows the boundaries of an abscess produced by perforation of an ulcer in the anterior wall of the stomach. It will be seen to be limited below by adhesions between the great omentum and the anterior abdominal wall, and above by the diaphragm and anterior layer of the coronary ligament of the liver. Usually the abscess involves one side only, being bounded internally by the falciform ligament of the liver. In Fig. 90 is shown an abscess produced by a perforation in the posterior wall of the stomach. Here the abscess cavity involves the lesser sac of the peritonæum, the foramen of Winslow being occluded by adhesions. The third variety, shown in Fig. 91, will be seen to be in reality a retro-peritonæal abscess. Such an abscess will be caused by a perforation in the posterior wall of the stomach, where the two walls of the lesser sac of the peritonæum have previously become adherent, or, in some cases, by perforation of a duodenal ulcer.

Operation.—The treatment of the condition resolves itself into drainage of the abscess, any attempt at closing the perforation in the stomach being generally out of the question.

If a diagnosis of sub-phrenic abscess has been made, and the limits

FIG. 89.

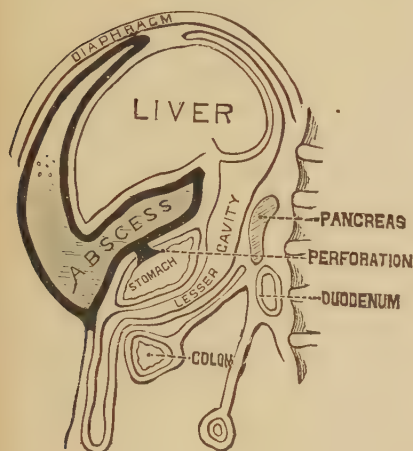


Diagram of sub-phrenic abscess from perforation of the anterior wall of the stomach. (Greig Smith.)

FIG. 90.

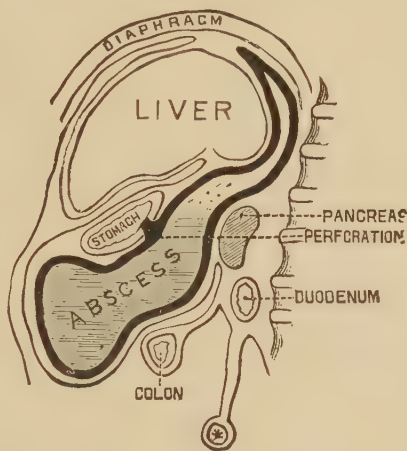


Diagram of sub-phrenic abscess from perforation of the posterior wall of the stomach. (Greig Smith.)

of the abscess can be ascertained, it may be opened through the lower part of the chest wall, portions of one or more ribs being resected. Care must, however, be taken to prevent infection of the pleural

FIG. 91.

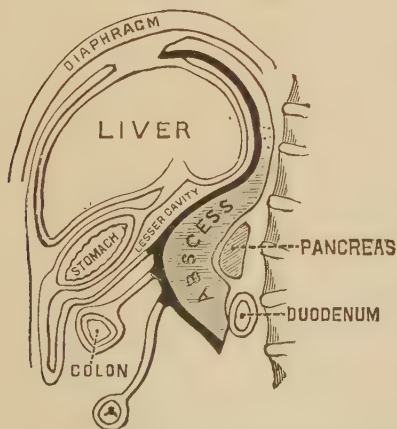


Diagram of retro-peritoneal sub-phrenic abscess. (Greig Smith.)

cavity, by suturing the two layers of the pleura to one another, if these are not found to be already adherent. It is far better to avoid the pleura altogether by removing a piece of rib which is known to be below the normal level of the pleural reflection. If the membrane be

found unusually low, it may be possible to displace it upwards. By adopting this plan the grave dangers arising from pneumo-thorax and empyema may be avoided. The abscess may then be reached by pushing a director through the diaphragm and enlarging the opening with dressing-forceps. In the majority of cases, however, the condition will be first discovered on exploring the abdomen by means of a median incision. If the abscess is of the first variety, it will be opened at once on dividing the peritonæum, and may be drained entirely through the anterior incision, or a counter-puncture may be made in the side. Should the abscess involve the lesser sac of the peritonæum, it may be opened through the gastro-hepatic omentum after the general peritonæal cavity has been shut off by careful packing with iodoform gauze, but it is better to drain it through the left loin.

Infection of the general peritonæal cavity can be avoided either by drawing off the pus with an aspirator, or by making only a small opening and then carefully mopping up the pus as fast as it escapes. After the cavity has been completely emptied and wiped as clean as possible, it must be explored by the finger, and a counter-opening for drainage made in the side. The soiled gauze surrounding the anterior opening is now replaced by clean iodoform gauze, and the wound partly closed.

PERFORATION OF DUODENAL ULCER.

This occurs much more frequently in men than in women. The symptoms and the treatment of this condition differ considerably from those of perforating gastric ulcer, because of the site of the perforation in the first part of the duodenum, and within the right kidney pouch of the peritonæum in practically every case.

Mr. Rutherford Morrison described and drew attention to the importance of this pouch in 1894 (*Brit. Med. Journ.*, 1894, vol. ii. p. 968).

Mr. Moynihan (*Lancet*, 1901, vol. ii. p. 1658), in a valuable paper, pointed out the direction in which extravasated fluid travelled from it towards the appendix, giving rise to symptoms closely simulating those of appendicitis. In the 51 cases collected by him a correct diagnosis was only made in two, whereas the primary incision was made over the appendix in 19 cases. Mr. Maynard Smith (*Lancet*, 1906, vol. i. p. 895) gives an interesting account of an experimental and clinical study of the anatomy and pathology of the kidney pouch, and its bearing on perforating duodenal ulcer. The limits of the pouch are: *in front*, the lower surface of the right lobe of the liver and the hepatic flexure of the colon; *behind*, the peritonæum covering the right kidney, and the posterior abdominal wall which slopes backwards and outwards from the spine, determining the flow of liquid away from the foramen of Winslow, which with the duodenum form the inner boundary. The abdominal wall forms the outer limit; above, the pouch extends behind, to the right and in front of the right lobe of the liver. The lower boundary is less complete, consisting partly of the beginning of the transverse meso-colon, as it stretches back to the kidney and second part of the duodenum; to the outer side of this a leak may occur. Maynard Smith found that liquid which had been introduced

into the kidney pouch through a perforation in the duodenum, overflowed downwards along the outer border of the colon towards and ultimately over the pelvic brim, and in cases with short ascending meso-colon, the fluid passed forwards over the front of the ascending colon near the liver, and then passed downwards towards the lower end of the ileum and cæcum; the obliquity of the mesentery and the prominence of the spine preventing any flow towards the left until the pelvis had been flooded.*

These facts have an important bearing upon the diagnosis and treatment of perforating duodenal ulcer. Such perforations may be roughly divided into acute, subacute and chronic.

In the acute a large ulcer may tear away from adhesions and a copious extravasation may occur, leading to a diffuse peritonitis. In other cases the extravasation may be small in amount and become limited temporarily or permanently in the kidney pouch.

In nearly all the cases, there is a history of a sudden onset of severe abdominal pain, especially severe above and to the right of the navel. In 12 out of 14 of Maynard Smith's cases, the initial pain was above the umbilicus, and in 8 of these it was to the right of the middle line. Shock, more or less severe or even fatal (Moynihan), soon follows; and then a latent period, as in gastric perforation, may be deceptive and cause delay. Soon tenderness and rigidity come on, especially of the right side and the right flank, and the appendicular region may become immobile and dull, so that appendicitis is diagnosed. Later the signs of general suppurative peritonitis develop, with general distension and tympanites. From the first the patient looks gravely ill, and his pulse after the initial shock becomes gradually quicker as a rule.

A previous history of digestive troubles is unusual, which is a contrast with the history of gastric perforation.

From appendicitis this condition may be distinguished by *a careful study of all the available evidence, the history of a very sudden and severe onset is against appendicitis*, although a latent abscess may occasionally burst and give rise to very sudden symptoms.

Maynard Smith mentions the interesting case of a man who, whilst cycling, was seized with severe and agonising epigastric pain, and faintness. He was admitted into the hospital in a collapsed condition, with rigidity of the upper half of the right rectus; a diagnosis of ruptured duodenal ulcer was made, but the operation disclosed "a gangrenous appendix with an abscess which had burst, causing general peritonitis."

The diagnosis is rendered more difficult because the appendix may be placed higher than usual and moreover, appendicitis and perforation of a gastric and duodenal ulcer have been shown to occasionally co-exist or follow one another very closely.†

* Russell, Wallace, and Box (*St. Thomas's Hosp. Reports*, 1897) made some similar observations on the anatomical importance of the "peritonæal watersheds."

† Warren Low, Bolton Carter, Lediard and Sedgwick, Watson Cheyne, quoted by Maynard Smith (*loc. supra cit.*), and Graham (*Ann. of Surg.*, 1904, vol. 40, p. 447). Gutch (*Lancet*, vol. i. 1906, p. 1243) records the case of a man of 36 who died from hæmorrhage from and perforation of an acute ulcer of the duodenum; death occurred within two days of an operation for the treatment of appendicitis with abscess formation. A concretion was found in the appendix, but the latter could not be removed.

A mistaken diagnosis of intestinal obstruction has been made, and several cases are mentioned by Lockwood.* The rigidity, fixation, tenderness (especially on the right side), and other signs of early peritonitis, and the incompleteness of the constipation may serve to prevent this mistake in most cases. Leucocytosis may also help.

It is almost impossible to tell the difference between a perforation of the duodenum and a similar condition of the pyloric region of the stomach in some cases, for the fluid may pass into the kidney pouch and travel down the right flank exactly as in duodenal ulcer. It must not be forgotten that some acute diseases that may be confounded with gastric perforation may likewise be mistaken for perforating duodenal ulcer (*vide* p. 315). In one case under my care, the patient had been thought to be suffering from lead colic, and had been treated with purgatives for twenty-four hours before I saw him.

Treatment.—As for perforating gastric ulcer, an operation should be performed without delay and with as much speed and care as possible. The abdomen should be opened through the upper part of the right rectus muscle, and the fluid mopped away and the wound well retracted. Bile-stained fluid often escapes.

The ulcer is most commonly met with on the anterior aspect of the first piece, and is thus accessible. Sometimes it is on the posterior surface, as in one of Mr. Lockwood's cases, in which the necropsy showed that it would not have been seen at an abdominal exploration.†

The perforation should be closed by means of one or two layers of sutures as in the treatment of perforated gastric ulcer. It is especially important here to pass the sutures in the same direction as the axis of the bowel, to avoid narrowing of the canal when they are tied. Excision is less to be recommended than in gastric cases, for it may be difficult to close the enlarged aperture without constricting the duodenum. Moreover, there are often other ulcers in the duodenum or stomach as pointed out by Moynihan (*loc. cit.*). An omental graft may be used to fortify the line of suture, and in some cases, where it is not possible to close the perforation, or this involves great narrowing of the lumen, a primary gastro-jejunostomy may be necessary, but it should not be done in other cases unless the condition of the patient is very good. In most cases, the patient cannot stand a prolongation of the operation, and it is better to defer gastro-jejunostomy until a later date, and until symptoms indicate the need of it. The same may be said of Finney's operation. In one of Mr. Moynihan's cases, in which primary gastro-jejunostomy was performed, the patient, who had no general infection but only a little plastic local peritonitis, recovered; but in another, "the patient never rallied from his collapse."

Irrigation may or may not be advisable according to the extent of the extravasation, but in most cases, it is better to use it. In five out of the seven recoveries recorded by Maynard Smith, irrigation was performed, and the four cases in which mopping of the general peritonæum was employed all died, but these cases were also later in their disease

* *Lancet*, 1904, vol. ii. p. 968.

† So, too, in a specimen brought by Dr. Pye-Smith before the Pathological Society (*Lancet*, vol. ii. 1893, p. 1443), it is distinctly stated that the ulcer could not have been reached by operation.

so that the contrast in the results is not entirely due to the adoption or otherwise of irrigation.

Drainage is even more important.—Cigarette drains should be passed through the loin into the right kidney pouch, and if the pelvis has been soiled another should be inserted through a suprapubic wound. If the perforation has been sutured and drainage established posteriorly, the anterior incision may be safely closed, and the risk of ventral hernia thus diminished.

In Mr. Maynard Smith's collection of cases two were drained through the exploratory wound only, and both died; four had epigastric and pelvic tubes: two of these died, and one of the others needed secondary lumbar drainage; five had epigastric, lumbar and suprapubic drainage, and three of these recovered.

The semi-sitting attitude of Fowler should also be adopted, especially if no lumbar drain is used. Feeding per rectum should be adopted for some days to prevent irritation of the ulcer.

Prognosis.—Only seven of Mr. Moynihan's collection of 51 cases recovered, and the first was the one operated upon by Mr. Dunn at Guy's Hospital in 1896.

Since 1901, when Moynihan's classical paper was published, he has operated on five more cases, bringing his total up to seven (*Lancet*, vol. i. 1905, p. 340). Five of these patients recovered, but several of the cases were subacute and unaccompanied by extravasation, and this is true also of the case which recovered after primary gastrojejunostomy. Five recoveries occurred in the 14 cases recorded by Maynard Smith.

Crisp English (*loc. supra cit.*) found that two out of eight cases recovered at St. George's Hospital in the ten years preceding 1903.

D'Arcy Power (*Brit. Med. Journ.*, Jan. 10, 1903) records four cases, with three deaths. In one of these drainage was not used, and an unsuspected collection of pus was found between the liver and stomach.

Other successful cases are recorded by Gibbon (*Ann. of Surg.*, 1904, vol. xli. p. 109), Elder (*idem*, vol. i. 1906, p. 390), and Angus (*Brit. Med. Journ.*, Jan. 17, 1903).

There is little doubt, however, that the prognosis of perforated duodenal ulcer is much more grave than that of gastric ulcer, and this is due chiefly to delay in the treatment, owing to the deceptive nature of the symptoms, which may very closely simulate those of appendicitis. Weir found that of 13 patients treated by operation after thirty hours all died, but that of 12 operated upon before the thirtieth hour 66 per cent. recovered.

PERFORATION OF TYPHOID ULCER.

The diagnosis of this accident, which occurs in about 2.5 to 4.9 per cent. of all cases of enterica, is very important. Perforation accounts for at least a third of the deaths from typhoid fever (Harte and Ashhurst, *Ann. of Surg.*, 1904, vol. xxxix. p. 8; Goodall, *Lancet*, vol. ii. 1904, p. 9).

Unfortunately it is very difficult to arrive at a diagnosis, for few of the classical symptoms and signs of perforation present themselves

when perforation occurs during the depressed and almost moribund stage of the fever; a number of perforations are therefore not suspected until they are discovered at the autopsy. In others the diagnosis is only made when signs of peritonitis become evident, and an operation offers but a forlorn hope; peritonitis may also occur without perforation.

Perforation practically implies certain death, although rare and undoubted cases of spontaneous recovery have been recorded. Goodall relates one interesting case of this kind; the recovery occurred in one out of 68 cases which were not treated by operation, giving a rate of recovery of 1·4 per cent. for this series, and this is unduly hopeful.

The results of operation for this condition have during recent years undergone a steady improvement. In a list of 83 cases which Keen (*Surgical Complications and Sequelæ of Typhoid Fever*) gives, there were 16 recoveries; 19·2 per cent. of the operations, therefore, were successful.

Harte and Ashhurst (*loc. cit.*) collected the records of 362 cases treated by operation, and found that 26 per cent. of these had recovered, but these figures are far too favourable, for all the successful cases are published hurriedly, whereas the records of failures are buried in oblivion. Goodall (*loc. cit.*) mentions 49 *consecutive* operations at the Metropolitan Fever Hospitals, with four recoveries, or 8 per cent.

Elsberg (*Ann. of Surg.*, July, 1903) records 25 cases of typhoid perforation in children, with 16 recoveries; the prognosis is known to be much better in children.

Woolsey (*Ann. of Surg.*, 1906, vol. i. p. 652) records 17 consecutive hospital cases, with a mortality of 76·4 per cent., and F. T. Stewart (*Amer. Journ. of Med. Sci.*, May, 1904) publishes eight cases, with two recoveries. Meakins (*Montreal Med. Journ.*, October, 1905) records 1,230 cases of typhoid, with 32 perforations, 20 operations, and five recoveries. It is not probable that the percentage of recovery in *any series of a large number of consecutive cases* will be above 20 for many years to come, but this would be a brilliant success for a condition which is practically certain to be fatal unless an operation is done.

This improvement is doubtless largely due to earlier diagnosis of the condition, and therefore earlier operation; and as the feasibility of the operation becomes more fully recognised by physicians and surgeons alike, a still greater proportion of successes will no doubt be obtained. Keen may be quoted on this point; he says, "When once the physicians are not only on the alert to observe the symptoms of perforation, but when the knowledge that perforation of the bowel can be remedied by surgical means has permeated the profession, so that the instant that perforation takes place the surgeon will be called upon, and, if the case be suitable, will operate, we shall find unquestionably a much larger percentage of cures than have thus far been reported." But, although earlier diagnosis will do much to render these cases more hopeful, it must not be forgotten that many of them will still be practically hopeless from the first, both on account of the serious condition of the patient and of the technical difficulties which the surgeon will have to face. Some of the cases mentioned later—for instance, those of Thomas and Allingham—serve to emphasise the latter point.

The sudden onset of acute pain, especially in the right lower quadrant of the abdomen, accompanied by unusual tenderness and rigidity, strongly suggests the occurrence of perforation. Shivering is also an early sign, which Goodall lays stress on. Collapse of any marked degree is unusual, and its absence should not be allowed to mislead. A blood count is of no certain value except that the absence of any marked decrease in the number of red corpuscles indicates that the symptoms are not due to hidden intestinal hæmorrhage. Leucocytosis does not develop soon enough to be of value. An obliteration of the liver dulness if it occurs when the abdomen is flat may be of importance in confirming the diagnosis in a few cases, but its absence is not to be depended on. It should not be forgotten, however, that symptoms of perforative peritonitis may come on insidiously in typhoid fever, and that a patient may die with unsuspected general suppurative peritonitis; also that the collapse and exhaustion of the third week may simulate perforation.

Every effort must be made to arrive at an early diagnosis, however, and for this reason a surgeon should be asked to see the case when any suspicion arises, so that he may share the responsibility and operate without delay if necessary. When there is a strong suspicion of the occurrence of a perforation, an exploration should be undertaken and carried out as rapidly as possible if a capable surgeon is available. A blank exploration under favourable circumstances is not necessarily a very serious thing. Harte and Ashhurst give the following account of operations of this kind:

"Of 26 such operations in which no peritoneal lesions were found, 16 patients eventually recovered; only 10 died—a mortality of 38·46 per cent. Of the nine fatal cases in which the duration of life after operation is known, only three died in less than twelve hours. Of these three, 1 (Finney) died from pulmonary embolism following iliac thrombosis; the second (J. F. Mitchell) had had severe hæmatemesis and enterorrhagia shortly before operation, and was in a very precarious condition; while in the third case (Le Conte), in which the patient lived nearly seven hours after operation, the toxæmic state previously existing persisted without material change until death. In these three cases local anæsthesia was used, and in no way can the exploratory incision be held to have had any connection with the fatal termination."

The success of treatment depends very much upon early operation, without waiting for reaction from any collapse that may be present. Armstrong (*Ann. of Surg.*, November, 1902) found that ten operations performed during the first twelve hours were followed by four recoveries, whereas the same number of operations done during the second twelve hours were followed by only one recovery. All those operated upon after twenty-four hours died. Harte and Ashhurst's figures do not show the same striking effect of delay:

ANALYSIS ACCORDING TO DURATION OF PERFORATION BEFORE OPERATION.

Cases operated on.			Recovered.	Died.	Total.	Mortality.
First	12 hours after perforation	...	35	95	130	73·0 %
Second	"	"	22	62	84	73·8 %
Third	"	"	2	29	31	93·5 %
Over 36 hours	"	"	18	37	55	67·2 %

(Harte and Ashhurst)

and it is to be noticed that operations performed after thirty-six hours gave a mortality of only 67·2 per cent., but these cases were the few mild cases of slight and localised extravasation that had survived long enough to require an operation at this late period. The cases may be divided into two different classes—the first, in which perforation takes place during the height of a severe attack; the second, in which the perforation occurs during convalescence or a mild relapse. In the former class the prospect is almost hopeless from the first; in the latter, however, there is a considerable chance of success.

Two anatomical points should be remembered in connection with operation. The first is, that the perforation nearly always occurs in the last few feet of the ileum; according to Keen, it is in the ileum in 81·4 per cent. Harte and Ashhurst found that in 140 cases out of 190 the perforation was within a foot of the cæcum, and in only four was it more than a yard away from the ileocæcal valve. The appendix was found perforated in eight cases, and Meckel's diverticulum in three. The large intestine may be perforated in rare cases.

The other point is, that more than one perforation may be present. In Keen's list there were two or more perforations in 16·7 per cent. Harte and Ashhurst found that more than one perforation had occurred in 12 per cent. of 271 cases (*loc. cit.*).

Operation.—This must be carried out on the same lines as those described for perforation of a gastric ulcer, and as speedily as possible. Every precaution having been taken against shock, and some A.C.E. followed by ether having been administered, an incision is made through the sheath of the right rectus muscle, beginning a little above the pubis and extending upwards for three or four inches, the deep epigastric artery being avoided if possible.

Eucaine or cocaine local anaesthesia may be used in some cases. (*a*) For exploratory purposes in cases of grave doubt, a small incision may be made, and the lower three or four feet of the ileum rapidly examined, and a rubber tube passed into the pelvis and aspirated to find if any free fluid is present there; (*b*) for bad cases, where a general anaesthetic may be considered too hazardous. Dr. G. L. Hays (*Amer. Med.*, Sept. 6, 1902) records seven cases treated under cocaine anaesthesia. Three of his patients recovered. The handling of the intestines and the retraction of the wound are painful, and the mental distress produces shock, however (Woolsey, *loc. cit.*). Goodall found eucaine to be unsatisfactory in the only case in which he tried it.

When the peritonæum is opened the cæcum must be taken as a guide to the lower end of the ileum.* Enlarged mesenteric glands or zones of intense inflammation may also be guides to the perforation. As soon as this is found the coil should be safely brought outside the abdomen, packed around with hot sterilised towels or gauze tampons, and the perforation closed according to the general and local conditions which the surgeon has to face. Thus, (1) if the perforation is single, small, and the surrounding intestine in a condition to hold sutures, the perforation should be closed with sterilised silk, a continuous suture

* In an instructive case, nearly successful, as the patient lived until the sixth day after the operation, under the care of Dr. Cayley and Mr. Bland Sutton (*Clin. Soc. Trans.*, vol. xxvii. p. 137), the loop with the perforation in it was found in the pelvis.

first and then Lembert's sutures if there be time. (2) An omental graft may serve to plug and close some perforations of considerable size and with friable walls (Le Conte, *Phil. Med. Journ.*, Dec. 13, 1902). (3) If it is clear that the tissues are too friable to hold sutures, the perforation must be brought a little outside the abdominal wound and fixed by sutures which take up healthy bowel. Later on this artificial anus can be closed. (4) Where the mischief is very extensive, part of the intestine may be removed, and the ends united by a Murphy's button, or both brought outside and Paul's tubes fixed in them (*vide infra*).

In a case recorded by Dr. Thomson, of Texas (*Med. Chron.*, September, 1895), the cæcum was so disorganised as to require removal. The two ends were brought outside. Death took place eight hours later. Another case, showing how terribly altered the tissues with which we have to deal may be, is mentioned by Mr. H. Allingham (*Lancet*, vol. i. 1894, p. 675). Here the ileum was adherent to the sigmoid flexure and tore to pieces when touched. Suturing of the perforation being impossible, it was fixed in the wound. Death occurred twenty-four hours later. Lücke, of Strasburg (*Deut. Zeit. f. Chir.*, Bd. xxv. Hft. 1, 2, December, 1886), excised a wedge-shaped piece of the intestine. The operation took nearly two hours, and the patient never rallied, dying nineteen hours later.

Owing to the condition of the patient, any such steps as suturing and resection will be quite out of the question in most cases. Perhaps the plan that will give most successes will be to keep the perforation outside while the peritonæal sac is being thoroughly irrigated, and, a day or two later, to deal with it by suture or resection. Lücke, whose fatal case of resection I have referred to, advises that this step should be performed in two stages. Drainage is required in most cases by means of a cigarette drain passed into the pelvis, and another towards the perforation. In cases of local extravasation only, mopping may be sufficient, irrigation or drainage, or both, being dispensed with.

ABDOMINAL SECTION IN PERITONITIS.

A. In Septic Peritonitis.

In dealing operatively with a case of peritonitis the surgeon may find the following classifications useful:

(A.) *Cause*.*—i. *Peritonitis set up by mischief in the intestinal tract, whether accompanied by perforation or not.* Instances of this group would be hernia, appendicitis, intestinal obstruction, malignant disease, a caseating mesenteric gland, gastric ulcer, duodenal ulcer, typhoid perforation. ii. *Peritonitis set up by mischief in other viscera than the intestine, whether accompanied by a perforation or not, e.g., a suppurating ovarian*

* It is plain, I think, from such carefully reported cases as one by Dr. S. West (*Clin. Soc. Trans.*, vol. xix. p. 36), that cases of idiopathic purulent peritonitis do, very occasionally, occur. Dr. Hilton Fagge (*Guy's Hosp. Rep.*, 1875) stated that in an experience of twenty years he had only met with two cases of acute peritonitis in which no local cause could be found. The pneumococcus as a possible cause must also be remembered.

cyst, twisted ovarian pedicle, salpingitis, septic metritis, puerperal peritonitis,* ruptured bladder, suppurating gall-bladder or spleen. iii. *Traumatic peritonitis from the effects of contusion, gunshot or other injuries* (p. 422). iv. *Tubercular peritonitis*; this will be taken by itself. v. *Pneumococcal peritonitis*. (B.) **Extent and Progress.**—In the first three classes, which are always septic, the two distinct varieties of Mickulicz (*Centr. f. Chir.*, No. 29, 1889), which, though they run into each other, form two types, should always be distinguished in practice, viz., (1) *the diffuse septic peritonitis*, in which a large portion of the peritonæal surface is quickly infected, and, no adhesions being formed, the infection spreads rapidly; (2) *progressive peritonitis*, where the peritonæum is only affected at first in the neighbourhood of the cause. This focus is at first shut off by adhesions, but as the process gradually spreads, larger or smaller quantities of purulent exudation are encapsuled between the glued viscera. Mickulicz thinks that the treatment in the two must be different. In the first the whole peritonæum must be disinfected as far as possible. In the second, not the peritonæum in its whole extent, but each inter-peritonæal focus must be opened separately.

Operation.—We will take here a case where the septic peritonitis is diffused, where the surgeon is in doubt as to its cause, and where he is met by that combination of ominous conditions which confront us in these cases, viz., peritonitis and effusion, a septic condition, distended paralysed intestines, and exhaustion from pain, vomiting, &c.

In no case is the need of meeting shock more imperatively needed, viz., bandaging the limbs in cotton-wool, a hot-water mattress, or hot bottles to feet and trunk. A hot brandy or port wine enema should be given immediately before the operation, and saline fluid should be injected into the cellular tissue of the axillæ either during the operation or soon after it is finished. In the gravest cases, a solution of dextrose, 6 per cent., should be injected into a vein, at a maximal rate of a pint in ten minutes (Dr. Beddard, *Guy's Hosp. Gaz.*, 1905, vol. xix. p. 311). No more than two pints should be injected at a time. It is better to repeat the injection if necessary, than to overload the vascular system. In the worst cases no general anæsthetic should be given, but the local anæsthesia of cocaine or eucaine made use of. If, however, it is deemed advisable to induce general anæsthesia, ether or the A.C.E. mixture should be used, and only enough given to keep the patient quiet. There should be a plentiful supply of hot water which has been boiled, and care must be taken that no instruments or towels come in contact with the patient's vitals, either cold,† or just out of irritating chemical solutions.

* I fear the pathology and the published cases in which abdominal section have been resorted to here are alike most unfavourable. If the surgeon interfere early, he will probably only find a congested condition of the peritonæum. If he wait till tympanitis and purulent effusion be present, his efforts at relief will, I fear, be equally futile in the face of this severe general septic infection.

† A temperature of 105° will be sufficient for instruments, towels, &c., and, as I have said before, if any viscus has to be withdrawn outside the abdomen it should be the duty of one assistant to keep its temperature from falling, and of one more to keep him supplied with towels or tampons previously sterilised and wrung out of sufficiently hot water.

The skin having been well cleansed, the abdomen is opened by a sufficiently free incision near the middle line. Now, and throughout the operation, every manipulation is to be carried out as quickly as possible. Slow operation means failure (Lockwood).*

When the peritonæum is opened the next steps will depend upon the history of the case, and the fluid or gas which escape. If either of the latter be fæcal, the ileo-cæcal region is first examined, owing to the frequency with which the chief causes of inflammatory or mechanical obstruction are found here. If none are found, and the cæcum is distended, it is clear that the obstruction is in the large intestine, or is inflammatory. To settle this point the sigmoid flexure is next examined. If it be distended, and if there be no obstruction in the rectum—a point previously ascertained—the case is clearly not one of mechanical obstruction (Lockwood). The odourless gas and acid fluid mixed with recently taken food which escapes from a gastric perforation, the brownish acid fluid (occasionally fæcal) which may come from a similar lesion in the duodenum, have been alluded to above. Gelatinous-looking fluid probably indicates a ruptured cyst. Bloody ascitic fluid ordinarily points to hæmorrhage, or a malignant growth, or strangulation by a band or aperture.

In other cases, the history, the age, or the presence of enlarged mesenteric glands may point to the rupture of an abscess due to a caseating gland, or a rounded body in the pelvis to a suppurating ovary or fallopian tube.

We will next suppose a perforation closed, or some other cause removed, and now we have before us how best to deal with the conditions remaining, viz., the distended paralysed intestines, the removal of the septic fluid, and the question of drainage.

I have already, under the treatment of acute intestinal obstruction, dwelt upon the necessity of emptying the intestines before the abdomen is closed,† otherwise death is almost certain, from the continued toxæmia from the persisting passage of organisms, of which the bacillus coli communis is only one, and from the interference with the action of the lungs and heart by the pushed-up diaphragm.

The emptying of the intestines may be affected by multiple punctures (this being only safe if gas alone is present), with a fine trocar, such as a Southey's, the puncture being made obliquely. If the coats are softened and the puncture is not effaced by some of them gliding over the others, a drop of intestinal contents will very likely ooze out and continue to leak. This spot should be at once closed by a suture, with a very fine round needle, otherwise matters will only be made worse. Where fluids are also present, a temporary enterostomy tube (*vide* p. 132) may be fixed in the most distended coil and allowed to drain into a basin at the side of the table, during the greater part of the

* *Med.-Chir. Trans.*, vol. xxviii. Here will be found one of those rare cases of diffuse septic peritonitis saved by surgery. The cause was an unexplained perforation of the ileum.

† Travers, as Sir F. Treves (*loc. supra cit.*) calls him, "the father of intestinal surgery," long ago insisted upon the need of this, and urged that if the intestines were distended the operation was incomplete without this step. More recently Mr. Greig Smith Mr. Lockwood, and Mr. Baker have drawn attention to the need of this

operation, as recommended by Carwardine (*Practit.*, January, 1905). Mr. Carwardine's tube is expensive and may not be at hand, so that I use a simple flanged metal tube of small calibre or a Paul's tube, to either of which a long piece of thin rubber tubing has been previously tied. In grave cases the tube can be left in position for twenty-four hours or more, and the small aperture on the free border of the intestine can then be closed by inversion. Failing a suitable enterostomy tube incising one of the most distended coils is preferable to the use of a large trocar, which, however sharp, is liable to leave lacerated edges. The incisions should be about three-quarters of an inch long and made in the long axis of the bowel, on the aspect opposite to the mesentery. As I have before said, even after boldly incising, the amount of relief secured is often disappointing. This is due in part, as the late Mr. Greig Smith pointed out, to the acute flexures in which the distended intestines are held by the mesentery, in part, also, to the easily paralysed condition of the bowel. The opening being brought well outside, and safely kept there by an assistant, the surgeon, partly by tracing up and squeezing adjacent coils, partly by elevating one end and lowering the other of each distended loop, aids the evacuation. As each coil is emptied it is cleansed and returned, but any incised loop is kept outside till the last, then closed with Lembert's sutures and dropped back, unless drainage for a longer time is indicated.

In some cases an appendicostomy may be done for drainage as recommended by Keetley.

Where any perforation is present it may be simply enlarged for drainage—a plan adopted by Mr. Lockwood in his successful cases. Where a patch is gangrenous and there is no time for resection, a Paul's tube may be inserted—a plan adopted in a case of acute intestinal obstruction due to bands, with great distension of the small intestines, under the care of Dr. Perry at Guy's Hospital, in 1895. The lad recovered with a faecal fistula, which was subsequently closed (p. 419).

The next step is the cleansing of the peritonæal sac. The surgeon must here remember the distinction (p. 334), made by Mickulicz, between a *septic peritonitis, already diffuse and general, or one shut off here and there by adhesions, and so spreading more slowly*. In the cases where the peritonitis tends to be of a plastic character, where the intestines are matted here and there with lymph of varying tenacity, other parts of the peritonæal space appearing healthy, the surgeon has to face the following dilemma. If he separate the adhesions he will set up troublesome bleeding, he may break down important repair, and he may infect peritonæum still uncontaminated. On the other hand, by not disturbing the adhesions, he may leave pools of septic fluid, and he may miss, just when it is within his reach, the chance of closing some perforation, or of removing some other cause of all the trouble. I have mentioned such an instance at p. 321, in the treatment of perforated gastric ulcer.

Sir F. Treves's authoritative opinion in these cases inclines (*loc. supra cit.*; *Brit. Med. Journ.*, vol. i. 1894, p. 519) to "doing no more than is necessary, or as little as is obvious. A clump of adherent intestines will often cover and protect a perforation, and the ubiquitous

lymph will many times close such an opening with more speed and security than are provided by any system of suturing.* . . . The main purpose of the operation is to allow a noxious exudation to escape, and, if possible, to free the peritonæum of the cause of its trouble. . . . If the operator can rid the serous cavity of the effects of the perforation, he may very often leave the breach itself to be dealt with by natural means."

Sir F. Treves goes on to say that irrigation is certainly not suited to this class of case—peritonitis partially localised by adhesion—gauze sponges forming here the best means of cleansing the peritonæum. Drainage is seldom required, and when employed is best provided for by strips of iodoform gauze passed among the coils to the necessary depth. The same authority recommends, in this form of perforation, a liberal dusting of the serous membrane with iodoform, save in the case of children.

My own opinion with regard to these cases of septic peritonitis partially localised by adhesion is, that the chief point is drainage, especially where the fluid is purulent and foetid. Drainage must here be secured at all hazards, both by gauze drains and tubes from in front, and by incisions behind. Repeated operations may be required.

It is in cases of *diffuse septic peritonitis* that the question of the best means of cleansing the peritonæal sac will especially arise. There is still considerable difference of opinion on this point, some surgeons strongly recommending and always practising irrigation, whereas others condemn it and rely entirely on sponging; others, again, make use of neither (*vide infra*). Even laying individual opinion on one side, it is no easier to judge from results, since successful cases treated by either method are necessarily few and far between. Moreover, in studying recorded cases it becomes quite evident that the condition described by different surgeons under the heading of general septic peritonitis is not always really the same.

Again, it should be borne in mind that the result in any given case depends largely upon two important factors, namely, the virulence of the infection and the resisting power of the individual, neither of which can be in any way gauged by the appearances on abdominal section; so that, on the one hand, in a case of infection with a virulence of low type in a patient of high resisting power, either irrigation or sponging may, although incomplete, be sufficient to turn the balance in the patient's favour; on the other hand, a very virulent infection in a patient whose resisting power is small will be certainly fatal, and this result will not be affected in the least by either irrigation or sponging. Finally, it must be borne in mind that, whichever method is adopted, and however completely it is apparently carried out, anything like a bacteriologically complete cleansing of the infected surface is quite out of the question.

Where the fluid is non-infective, *e.g.*, blood, hydatid, bile, &c., where it is recent or not widespread, and where the operation-area can be safely circumscribed, cleansing of the peritonæal sac can be best and

* Sir F. Treves refers to Kaiser's statistics (*Deutsch. Arch. f. klin. Med.*, 1876). Here 30 cases of operation for perforative peritonitis were collected with 11 recoveries. In five of these the exact site of the perforation was not ascertained.

most safely accomplished by the use of gauze sponges, either used dry or wrung out of boiled water or salt solution.

Where, however, the fluid is septic and widely spread, irrigation with sterile salt solution introduced at a temperature of 105° — 110° F. is probably preferable, a small incision being made about two inches above the pubes and a tube inserted to facilitate the circulation of the fluid. In Sir F. Treves's words this should be "introduced at low pressure, but in a wide stream. The irrigation tube is of soft rubber, and may have a diameter of three-quarters of an inch. The tube itself is introduced into the belly cavity. The flow through it can be regulated by a clip. Any form of rigid nozzle is to be most strongly condemned. The solution should flow gently into the abdomen. The peritonæal cavity is to be flooded, and not to be scoured out with a violent stream of water which hisses and rushes from a vulcanite nozzle like a miniature fire-hose. When the belly cavity is quite full of fluid, the surgeon's hand, which is already in position, is moved to and fro amongst the intestines with great gentleness. By a movement of the hand, and pressure here and there, the fluid overflows from the wound, and is replaced by the steady stream. As the water which escapes becomes clear, the upper end of the table is raised so that the shoulders are much elevated, and then little has to be done but to wash out the most dependent parts, including especially the pelvis.* Finally, what fluid remains in the pelvis is removed with sponges, and a sponge on a holder is retained in the bottom of the pelvis during the introduction of the stitches, and only withdrawn at the last moment."† It is important that the temperature be constant, the abdomen not over-distended, and that the stream be not directed against the diaphragm. If these precautions be neglected alarming dyspnœa may take place (Reichel). Polaillon has noticed three cases of cessation of respiration in the human subject during irrigation (Treves). The most suitable fluids are the saline infusion already advised, or boiled water, or dilute solutions of boric acid. In order to render the flushing more efficient some surgeons allow the intestine to escape into hot moist towels. Mr. M'Cosh (*Ann. of Surg.*, vol. i. 1897, p. 686), with an experience of 43 cases, makes a practice of this, except where the distension is enormous and the heart's action very weak. He says: "Where possible, however, even at a great risk, the intestines are removed, and if well protected by hot towels, I have not found that this evisceration increases to any extent the shock of the operation." Dr. Finney, again, who reports a brilliant group of five successive cases, all of which were cured (*Johns Hopkins Hosp. Bull.*, July 1897), considering the usual means adopted inadequate, goes even further than this, and, before returning the intestines, thoroughly cleanses each loop with gauze wrung out of hot salt solution, using "considerable force." It may be mentioned that Dr. Finney considers thorough wiping with sponges

* From first to last the whole peritonæal sac and its contents must be gone over as methodically as possible. For ensuring this the excellent directions of Dr. Maclaren, of Carlisle (p. 320), should be remembered.

† There are some who hold that irrigation fluid may safely be left behind, as the peritonæum has well-known powers of absorption. Such too often forget that here we are dealing with a damaged sac, not the healthy one of experimenters.

more useful than flushing. General experience has now shown that evisceration is to be avoided, whenever possible, for it greatly increases shock and lengthens the time of the operation. Moreover, sponging or rubbing away adherent lymph is neither necessary nor wise, for this only removes nature's protection and exposes raw surfaces for fresh infection and absorption.

Drainage.—Where the fluid was septic this should be employed. First as to *site*. As, at a necropsy, fluid is always found in the pelvis, and sometimes only there, a drainage-tube containing a wick of gauze should always be placed in the pelvis, and in the female a drainage-tube should be inserted into Douglas' pouch through the posterior wall of the vagina. Other rubber tubes, of appropriate size and properly fenestrated, should be placed in those areas which have been most disturbed (Treves), or where especially septic collections were found, or where bleeding may be going on. These must be brought out in front, or, by counter-puncture, laterally or behind. Provisional sutures must always be inserted. The tubes may usually be removed in forty-eight hours. If the discharge that comes out of any of them be free or foul, the tubes should be cleansed and reinserted. Irrigation by the tube may produce fatal collapse, and it is difficult to make certain of the return of the fluid sent in.

Gauze drains are made of strips of iodoform gauze about one inch and a half wide and containing five or six layers.* They are largely used by Continental surgeons.† The objection to this form of drainage is the risk of poisoning, the difficulty and pain in removing them, and the greatly increased risk of hernia. As it is certain, however, that the necropsies in septic peritonitis show, most constantly, inadequate drainage, I am of opinion that the above means of drainage should be much more extensively employed, until replaced by treatment more satisfactory. The great importance of drainage in these cases is emphasised by the fact that of 10 cases of generalised septic peritonitis treated by Dr. Van Arsdale by drainage only, recovery took place in eight (*Ann. of Surg.*, vol. ii. 1897, p. 238). Neither flushing nor sponging was employed here, but simply the making of two incisions and introducing "large rubber drainage-tubes in different directions through the openings, and packing with iodoform gauze." The recent results of Murphy and others also show the great value of simple incision and drainage. Le Conte (*Ann. of Surg.*, 1906, vol. i. p. 231) states that by adopting this method Murphy has only lost one of his last 29 cases of general suppurative peritonitis. Great care was taken in the after-treatment in every way (*vide* p. 305).

Where the peritonæal surface has been unavoidably damaged, as in the separation of adhesions, the treatment must vary according to the

* Jalaguier (*Bull. de Mém. de la Soc. de Chir.*, 1891, p. 800) is quoted by Sir F. Treves as having passed these strands in all directions amongst the intestinal coils from the diaphragm to the pelvis with a good result.

† The Mickulicz drain or tampon is used to check dangerous abdominal hæmorrhage, to close extensive breaches in the peritonæum, or to shut off structures which are septic. It is a sheet of iodoform gauze placed *in situ* as an open bag, and stuffed with strips of the same material. These are removed piece by piece after the first forty-eight hours; a few days later, when empty, the bag itself is removed.

severity of the lesion. In slight cases suture or inversion may be done, in severer ones an omental graft employed, or tamponnading with iodoform gauze. The latter is the most generally applicable, and that with the least delay.

After-treatment.—Two points only will be referred to here. They are the most important. One, the need of persevering persistence in combating shock and collapse; the other, the value of aperients. If tympanites and distension supervene or continue, the paralysed, thinned intestinal walls probably allow of the passage through of bacteria or their products, which are taken up from the peritonæal sac, thus giving rise to a toxic state. The passage of the long tube, the introduction of enemata containing *ol. ricini* ʒij., *ol. terebinth.* ʒss., or *mag. sulph.* ʒij.; or, if the patient can swallow, the administration of calomel gr. ij. every two hours may be very useful. Dr. M'Cosh (*loc. supra cit.*) advocates injections of magnesium sulphate into the intestine at the close of the operation. He makes the injection into the small intestine as high up as possible, and uses a saturated solution containing between one and two ounces of magnesium sulphate, the needle puncture being closed with a Lembert's suture. Where the bowel has been emptied by incision or enterostomy tube the above may not be required.

B. In Tubercular Peritonitis.

Although the question of the advantage of operation in this disease has been much debated, there can now be little doubt that, in suitable cases, great benefit has often resulted from operation. It is still very difficult to determine the actual percentage of permanent cures, owing to the small number of cases that have been efficiently followed up. Dr. H. P. Hawkins (*St. Thomas's Hosp. Rep.*, 1892), from an examination of 100 cases treated consecutively at St. Thomas's Hospital, came to the conclusion that there is but little difference in the mortality whether operation is resorted to or not. Such slight difference as does occur is in favour of operation. The following figures, quoted by Mr. Watson Cheyne (*Lancet*, vol. ii. 1899, p. 1725), are distinctly more favourable. In 1895, Roersch published 358 cases with the following results. The deaths immediately due to the operation numbered 32, deaths at a later period (within eighteen months) and due to extension of the disease, general tuberculosis, &c., numbered 51. In the rest of the cases improvement followed, and many were apparently cured. For instance, in 53 cases two years and upwards had elapsed since the operation, and the patients were apparently quite cured. According to these figures, improvement or cure therefore results in 75 per cent. of the cases operated on. As pointed out by Mr. Watson Cheyne, this percentage is too high, since many cases relapse even after prolonged periods of apparent cure, and, moreover, the successful cases are more likely to be published than the failures.

Mr. Watson Cheyne, as a result of his own valuable experience, considers that improvement takes place in about 50 per cent. of the cases, and he states, moreover, that in many the rapid improvement after operation was most remarkable. He says: "I must confess that I have been surprised at the recovery of some of these cases. On opening the abdomen one finds tubercles everywhere, the intestines protrude from the wound and are seen to be red, inflamed, and covered with tubercles,

some of them sometimes of considerable size, the abdominal cavity feels like a bag of rice; and yet in these cases recovery may follow. In two cases in which I made a very bad prognosis after the operation, on account of the size and the number of the tubercles scattered all over the intestines and abdominal cavity, recovery took place rapidly, and apparently completely."

Halstead (*Amer. Med.*, Jan. 31, 1903) states that over 1,500 cases of tuberculosis of the peritonæum, treated by operation, have been recorded. The percentage of recoveries in the ascitic form is from 40 to 50 per cent., and in the adhesive form about 25 per cent. After five years' freedom from recurrence, the disease may be considered to be cured.

Lobsingier (*New York Med. Journ.* Dec. 5, 1903) states "that statistics show 50 per cent. cured and 25 per cent. greatly benefited after the lapse of from four to five years from the date of the laparotomy." Death often occurs from tuberculous lesions in other parts of the body.

From the point of view of surgical interference in this disease, the following classification of the principal types of the affection is important.

A. *The Ascitic*.—Here the inflamed peritonæal sac and its contents are studded, as far as can be seen, with hosts of grey "sago grain" granulations, tending to become confluent. Caseation is absent, or only present in a very early stage. The fluid is rarely sero-purulent. Adhesions are absent or insignificant. The fluid here may be localised and encysted. The ascitic form may come on very insidiously, and is not uncommonly the subject of a mistake in diagnosis. B. *The Caseating and Purulent*.—Here caseation is always present; the amount of pus varies. Usually this is abundant, and is too often encysted, imperfectly, in many collections. More rarely the caseation is dry, unattended with effusion, the intestines being matted together by adhesions which are themselves infiltrated and caseating. If the adhesions are separated, hosts of small loculi present themselves, with scanty fluid, usually purulent. The caseating is the variety which we see so typically in wasted children with hectic, vomiting, and diarrhoea. C. *The Fibrous*.—This is the rarest, but a favourable variety. The bacilli are probably few. Caseation is absent, and any fluid present serous and scanty. In this form and the second, if such parts as the omentum and mesentery are densely infiltrated, a new growth may be closely simulated.

The amount of improvement after operation that may be expected in any case of tuberculous peritonitis depends chiefly upon two considerations—(1) the stage which the disease has reached, and (2) the type of disease that is present.

(1) *The Stage of the Disease*.—It is most important that the operation should be undertaken before the vitality of the patient has been much diminished by general failure of nutrition, hectic, or tuberculous disease of other parts, &c., in order that the effect of the operation itself may be quickly recovered from. For in the advanced stages of the disease the shock alone of the operation may be sufficient to bring about a fatal result, or in any case to hasten the end. Mr. Watson Cheyne's advice (*loc. supra cit.*) on this point may be quoted: "I should say that in practically all cases where improvement does not follow under medicinal treatment after a reasonable time, say in from four to six weeks in

acute cases to from four to six months in chronic cases, the abdomen should be opened whether there be ascitic fluid or not. The operation may do good in cases where it is least expected to do so, and it is but seldom that it can do any real harm. Do not in any case allow the patient to go downhill too much, otherwise one cannot expect good results to follow, and it is fair neither to the patient nor to the surgeon."

(2) *The Type of Disease.*—The most favourable cases are those belonging to Class A, where there is free fluid and the adhesions are few. Class C is also favourable for operation, but Class B is distinctly unfavourable. Here the operation may do much harm, for adhesions are numerous and the wall of the bowel often much thinned. The result of manipulation is frequently the production of one or more fæcal fistulæ, with perhaps the setting up of acute suppuration. Improvement has, however, resulted even in some of these cases, for Mr. Watson Cheyne points out that there is no class of cases in which some improvement has not taken place, so that it is very difficult to absolutely exclude any case from operation.

Operation.—In the majority of cases this consists simply in opening the abdominal cavity by means of a median incision and letting out the fluid. The escape of the fluid may be facilitated by turning the patient on to his side, and also to some extent by sponging. Where the fluid is loculated by means of adhesions, the separate loculi may be made to communicate by gently breaking through such of the adhesions as may be necessary for this purpose. No extensive disturbance of the adhesions beyond this is either necessary or advisable. There is nothing to be gained by either washing out the abdominal cavity or by drainage, so that as soon as all the fluid has escaped the abdominal wound should be closed in overlapping layers, and the dressings applied. In carrying out this operation, in some cases an obvious primary seat, such as a tuberculous Fallopian tube or cæcum or appendix, may be discovered. This may be removed should the condition of the patient be such as to admit of the necessary prolongation of the operation, and if the adhesions are not so numerous as to render the procedure very difficult. In many cases, however, in which such a primary focus is found, it will be firmly fixed to other important structures or embedded in a mass of adhesions; in such cases the wiser course will generally lie in making no attempt at a radical operation, but in resting content with letting out the ascitic fluid as described above.

If on opening the abdomen the case is found to belong to Class B, great care and gentleness must be used in opening up and dealing with abscess cavities, for the walls of the intestines are frequently thinned and softened by the disease, so that any undue roughness in handling is extremely liable to result in rupture of the bowel, either at the time or later, causing fecal abscess or fistula. No attempt should be made in such cases at eradicating the disease, but abscess cavities may be treated as tuberculous collections elsewhere are treated, by evacuating the contents, gently swabbing out the cavity with pledgets of sterilised gauze, introducing sterile iodoform emulsion, and then closing the cavity. If the pus is, however, found to be fæculent owing to infection from the bowel, the abscess must be either drained with a tube or stuffed lightly with tampons of iodoform gauze.

PNEUMOCOCCIC PERITONITIS.

Dr. W. F. Annaud and Mr. W. H. Bowen (*Lancet*, 1906, vol. viii. p. 1591) have recorded four cases of this rare disease, and they were able to collect 91 cases, including their own; all these patients were children under the age of 15; the disease is much less common in adults. In 30 cases the peritonitis was secondary to a lesion elsewhere, especially in the lungs and pleura. Primary infections had occurred in the throat or middle ear in several cases.

In 45 patients the peritonitis was considered to be primary, possibly due to infection from the intestines, especially from the appendix. In 44 cases there was such a rapid spread of the infection that it was impossible to decide upon any primary seat.

The pus is nearly always thick and odourless, and it may have fibrinous or jelly-like masses floating in it, and layers of greenish-yellowish lymph are deposited on the peritonæum and intestinal coils. The peritonitis may be localised or diffuse, sub-acute or acute. The sub-acute form generally starts acutely, but there is a great tendency towards the formation of circumscribed sub-acute abscesses, so that a diagnosis of tuberculous peritonitis is quite likely to be made. The acute form is generally mistaken for peritonitis due to appendicitis, unless a primary pneumococcal lesion is known to exist. The character of the pus and the absence of any discoverable source of the peritonitis should make the diagnosis clear during the operation.

Treatment.—Localised abscesses should be incised and drained. In the acute diffuse form, the diagnosis will only be made when the abdomen is opened for peritonitis of uncertain cause. Bowen advises mopping out the pus, and closing the wound completely if the pus be sweet; but if the pus be evil smelling indicating mixed infection drainage should be adopted. I should be inclined to leave a tube in the pelvis in every case, and Von Bruns believes drainage to be necessary.

The Prognosis.—The following table from Annaud and Bowen speaks for itself.

Variety of peritonitis.	Number of cases.	Number of cases operated on.	Number of cases not operated on.	Result.		
				Recovery.	Death.	Uncertain.
Primary local	26	26	0	22	3	1
Secondary local	11	10	1	9	1	1
Primary diffuse	21	10	11	2	19	0
Secondary diffuse	19	5	14	3	16	0
Origin uncertain { local	8	8	0	6	2	0
	diffuse	6	3	1	5	0
Total	91	62	29	43	46	2

"Forty-five of the 91 cases had encysted peritonitis, of which 44 were operated on, and of these 37 recovered and six died; in two the result is uncertain. The other 46 cases were of the diffuse variety, of which 18 underwent operation. Of the 18 cases operated on six, or 33·3 per cent., recovered, whereas all those not operated on died. The one case of the local variety not operated on recovered by spontaneous evacuation of the pus. The above table shows that recovery occurred in 86 per cent. of those with the encysted form, whilst only 14 per cent. of the cases with the diffuse variety survived."

It is probable that this form of peritonitis is more common than is suspected at present, and that a more general bacteriological examination of the pus in cases of peritonitis will prove this assertion.

ENTEROSTOMY—FORMATION OF AN ARTIFICIAL ANUS IN THE SMALL AND LARGE INTESTINE.

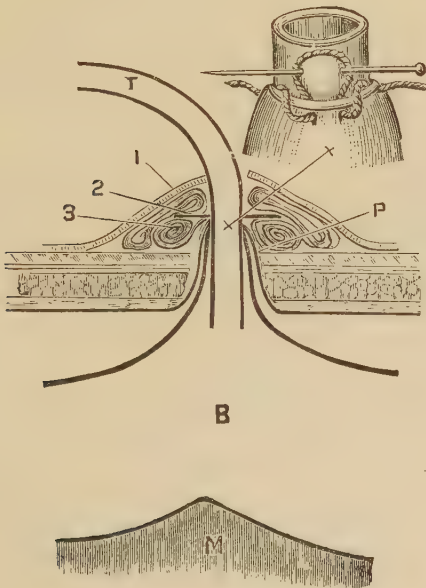
This subject has, in part, been already considered under Colotomy; I now allude to it again to aid my readers when they have to face the following indications:

A. Chiefly referring to the Small Intestine and Acute Intestinal Obstruction.—Either a temporary or a permanent opening may be made. **Temporary drainage** is called for (1) when the surgeon decides, owing to the patient's condition, not to perform an ordinary abdominal section, but to relieve the distension as a temporary measure by opening the bowel above the obstruction; (2) in those cases (already referred to, p. 264) in which distension of the small intestine is considerable, and in which the obstruction has been successfully relieved.

A **permanent opening** will be necessary when the surgeon cannot detect the site of obstruction, or where he finds it, but cannot remove it or make a short circuit. Under these circumstances he may be driven to open the small intestine. The opening must be as near the cæcum as possible, in order to avoid the danger of death from starvation which would be caused by an opening high up in the small intestine. The only certain way of localising any part of the small intestine is to trace it to or from one or other end. If valvulæ conniventes can be felt by drawing the bowel between the fingers and thumb, then it is certain that the loop is above the middle of and far too high in the small intestine, for making either an artificial anus or intestinal anastomosis. The thinner walled and smaller of calibre the loop is found to be in comparison with others, the more likely is it to be low down in the ileum, but too much faith must not be placed in this, for hypertrophy from obstruction may make the test of little value. Dr. Monks (*Trans. Amer. Surg. Assoc.*, 1903, p. 405) has pointed out that any loop picked up in the upper and left third of the abdomen probably belongs to the upper third of the jejunum, any in the lower and right third to the lower ileum, and any in the middle third to the middle third of the small intestine. The more fatty the mesentery, and the more complicated the arrangement of its blood vessels, and the shorter the vasa recta, the more certain is the loop to belong to the ileum low down.

These operations are merely palliative, and are only to be made use of when the adoption of other and more desirable courses is impossible, or when the surgeon feels sure he can open the small intestine low down. It has been urged by those who have recommended such operations—*e.g.*, Nélaton, 1840—that some obstructions relieve themselves if a temporary outlet has emptied the accumulation above. This may be true of a very small number of cases—*e.g.*, volvuli which have not gone too far, and loops which are incarcerated rather than strangulated. Another point urged in favour of this operation is that it involves much less shock and disturbance of the abdominal contents. This last is true. But, from what I have seen, this operation

FIG 92.



To show Greig Smith's method of performing temporary enterostomy.

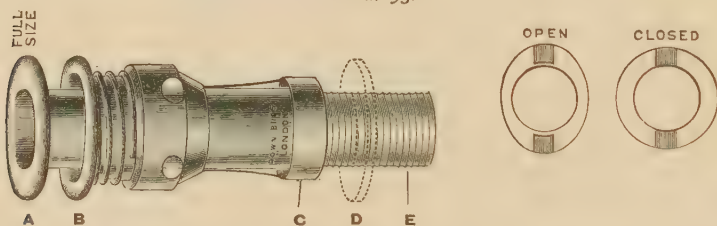
B, Bowel. M, Mesentery. T, Rubber tube. P, Peritonæum. 1, Strapping fixing dressing. 2, Pin holding bowel and tubing in position. x—x, Enlarged view of plan of fixing bowel and tube by pin and suture. (Greig Smith.)

usually fails, by leaving irrecoverable mischief behind in the very cases to which it is best suited—*viz.*, acute obstruction where the lesion cannot be found, or where it cannot be dealt with, or is beyond recovery. Even if it succeed it is at the cost of great and lasting inconvenience. Owing to the liquid state of the contents, control is very slight, and the raw and eczematous condition of the tissues adjacent to the opening is productive of great discomfort. Unless the condition of the patient is very grave, it is far better to perform some form of lateral anastomosis, than to make an artificial anus, especially in the small intestine. When the obstruction is acute and irremovable, it may be safer to form a temporary enterostomy, than to short-circuit at once, but a secondary anastomosis should be undertaken if

possible to relieve the patient of the intolerable nuisance of a permanent fæcal fistula, especially in the small intestine. In some malignant obstructions within the pelvis this may not be practicable.

Temporary Drainage of the Small Intestine (Figs. 50 and 51).—The following method, in which rubber tubing is used to carry off the contents of the bowel, was described by the late Mr. Greig Smith (*Abdom. Surg.*, p. 687), and will be found to be easy, rapid, and satisfactory. It is described as follows:—"Between the second and third fingers of the assistant's left hand and the same fingers of his right hand, held back to back, a V-shaped piece of the intestinal border is compressed and excluded. On the free border of this fold the incision is made large enough to admit the tubing. If the bowel is properly held no gas or fluid escapes. With fine peritonæal catch-forceps the mucous membrane on each side of the small incision is grasped and pulled out a little way, and the tubing, stretched over a blunt probe, is pushed through the opening. The tubing is at once fixed to the margin of the incision by a safety-pin or two, or in the manner shown in the

FIG. 93.



A, Flange of inner tube. B, Flange of outer tube. C, Spring which by compression releases the clutches. D, Fly nut to protect spring (optional). E, End of inner tube to which india-rubber tubing is attached.

Carwardine's enterostomy tube.

diagram (*vide* Fig. 92). If it fits accurately there will be no escape of intestinal contents by its side. The fingers of the assistant are now removed, and the gases and fluids permitted to escape. When the bowel has collapsed the loop is cleansed and returned into the abdomen, leaving outside about an inch of bowel containing the tubing. The tubing should at its inner extremity clear the parietes, but need go no further inside. The parietal sutures already placed are now tied, all save one, which is to be tied in a few days when the extended loop is returned."

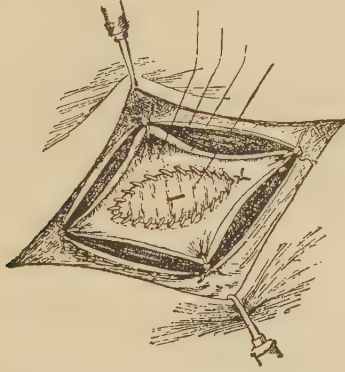
Carwardine's self-retaining enterostomy tube is a great improvement upon the rubber tubing, but it may not be available. Lilienthal's self-retaining trocar and cannula, although complicated, may be found useful (*Ann. of Surg.*, 1906, vol. i. p. 912).

Instead of the above the following method may be used. The abdominal incision is closed with the exception of an inch and a half at the lower part. Here the parietal peritonæum is first united to the skin by a few points of suture. The loop of intestine which it is intended to drain is then carefully attached to the parietal peritonæum by a continuous silk suture, picking up the serous and muscular coats of the bowel on the one hand, and the parietal peritonæum on the other, as shown in Fig. 94. The sutured edges are then sealed with collodion.

The bowel is now punctured by a trocar and cannula which have been passed through a piece of thin india-rubber sheeting, the contents of the bowel being allowed either to pass into the dressings or being led away to a suitable vessel by means of a tube attached to the cannula, or a small Paul's tube may be inserted within an area encircled by a purse-string suture, which serves to fix the tube. A tube made for me by Down Brothers has the advantage of having an oval flange, which allows the tube to be introduced through a small incision, which is a distinct advantage for temporary enterostomy. Pliable rubber tubing can also be fixed to the end of the tube with ease (*vide* Fig. 56, p. 133).

Formation of a Permanent Artificial Anus in the Middle Line (Fig. 95).—The contents of the peritonæal sac having been shut off by gauze tampons and sponges, the surgeon makes an artificial anus in one of the following ways :—A loop of intestine, as near the obstruction as

FIG. 94.

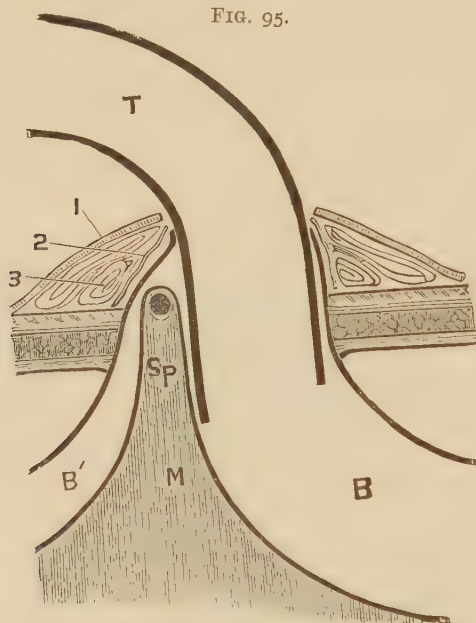


Fæcal fistula. The parietal and intestinal peritonæum have been united by a continuous suture (Kocher). This figure should be contrasted with Fig. 96, which shows an artificial anus. Here there is no prolapsus and no spur, this opening being intended for temporary purposes.

possible, being chosen by its distension, congestion, &c., it is brought outside, and as much of the median incision as is feasible is safely closed with sutures. Those sutures which have to be placed nearest the intestine should not be tied, but kept clamped with Spencer Wells's forceps, so that the surgeon may easily draw out or replace some of the intestine as he requires. The intestine is now fixed either by some form of rod and sutures, or by sutures alone. In either case, if there be time, the parietal peritonæum may be sutured here and there, by points of fine silk passed with round needles, to the peritonæal coat of the intestine so as to shut off the general peritonæal sac, great care being taken not to perforate the lumen of the bowel. Then a piece of suitable bougie, glass rod, &c., which has been boiled, is passed through the mesentery, avoiding any vessels, so as to keep the loop well out of the abdomen. If too much bowel has been withdrawn some is now returned, the parietal wound closely sutured up to the projecting gut, and a few sutures placed between the intestine and the margin of the wound. These must not enter the lumen of the bowel. Finally, there must be

no twisting of the gut as it is brought out. If the rod is used, care must be taken that too much of the gut is not prolapsed, a point rather difficult to secure by this method. The smaller the prolapsus consistent with safety—*i.e.*, non-contamination of the peritoneal sac—the less the irritation and bleeding from friction of the dressings, &c., in the future, and the smaller the opening to be closed by any subsequent operation if this prove feasible. If sutures alone are used, most of the above steps are the same, but extra care must be taken in closing the parietal wound, so as to support the intestine which is to form the artificial anus, and additional sutures must be passed between the edges of the wound in

FIG. 95.



Formation of an artificial anus.

B, Bowel on proximal side of spur. B', Bowel below spur. T, Rubber tubing. Sp, Spur; at the top the black circular spot represents a section of the supporting rod. 1, Strapping. 2, Gutta-percha tissue. 3, Absorbent dressing. (Greig Smith.)

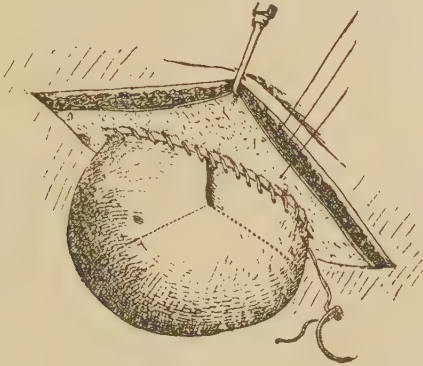
the parietes and the bowel. If this be distended much caution will be required lest the lumen is opened and the wound infected. The employment of the continuous suture is shown in Fig. 96.

Opening the Bowel.—If it be possible a few hours should be allowed to elapse.* But if immediate relief is required one of the following methods may be adopted. The whole of the wound, save where the opening is to be made, is covered with iodoform, and the sutured edges may be sealed with collodion and iodoform. (1) The bowel may be

* If this delay is possible, a guiding-stitch should be inserted (not entering the lumen of the bowel) at the point where the opening will be made. This renders easy what otherwise, owing to the rapid alterations in the surface of the bowel and landmarks, may prove very difficult.

opened by a trocar and cannula which have been passed through a piece of thin india-rubber sheeting (Cripps), so that the fluid fæces do not flood the wound, &c. A very useful precaution is to insert a temporary suture into the intestine, close to where the opening is to be made, so that by pulling on this the surgeon can keep the bowel forwards and the flow away from the wound. (2) A self-retaining enterostomy tube,

FIG. 96.

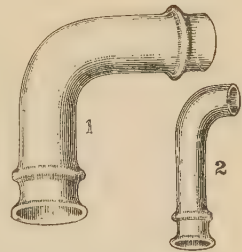


Formation of an artificial anus. A continuous suture has been used (Kocher). It is evident that there will be a good spur and plenty of prolapsus; much of this will be cut away later on. This, which is intended for a permanent opening, should be contrasted with Fig. 94, which shows a fæcal fistula only.

which does not allow any leakage, may be employed. (3) A piece of rubber drainage-tube may be inserted into the bowel, as described above in Greig Smith's operation for making a temporary fistula (*vide* Fig. 92). (4) A fourth method is to make use of a Paul's tube (Fig. 97). I have already referred to the use of the larger size in the performance of colotomy (p. 132).

The glass tubes are made in two sizes. That used for the colon or rectum (Fig. 97, 1) has been improved in shape by Messrs. Wright & Co., of New Bond Street, who have succeeded in bending it at the proper angle, which avoids all strain on the bowel. It measures 5 inches in length by 1 in diameter, has a double rim at the bowel end and a single rim at the distal end, and is bent at a right angle. The tube for the small intestine (Fig. 97, 2) is as light as is consistent with sufficient strength. It measures $2\frac{1}{2}$ inches by $\frac{1}{2}$ inch, and is bent at a right angle at the distal end. In either case, the end with the double rim is introduced into a small incision made in a loop of intestine, drawn out if possible, and safely shut off with aseptic gauze packing. The end thus inserted is then securely tied in with a silk ligature of sufficient stoutness. While this is being tied, an assistant with two pairs of dissecting-forceps should keep the edges of the opening in the bowel well pulled up over the rim of the tube. Fæces from the large

FIG. 97.



tube are received into a jaconet bag containing wood-wool, or other absorbent material, except the first rush in cases of obstruction, which is best received into a basin. To the small one an india-rubber tube is attached, which conveys the liquid fæces of the small intestine into a bottle, beneath an antiseptic fluid (Paul, *Liverpool Med.-Chir. Journ.*, July, 1892). Two objections have been made to the use of these tubes. One, that it is difficult to insert the tube without the risk of letting some fæces escape over the wound. This is certainly true when the intestine is distended and the fæces fluid. If, however, the loop to be opened is emptied into adjacent bowel, and temporarily clamped if possible, the introduction of the tube is greatly simplified; otherwise the operator may safely trust to drawing out the bowel as much as possible and isolating it with gauze. The other objection is that the silk ligature may cut its way through too quickly, especially if the bowel is much congested. Thus, the tube may be loose in two or three days; but it not infrequently remains for a week firmly adherent, partly because some of the circulation becomes re-established beyond the ligature, and partly owing to the copious exudation of lymph, which covers the bowel to the very end, quite concealing the ligature (Paul). The use of a purse-string suture to fix the tube in the bowel, and the prevention of undue tightness in tying in the tube, will help to lessen this trouble. If the tube becomes loose too soon, two or three Spencer Wells's forceps should be applied to the margins of the opening in the bowel, so as to keep this forward until the parts are more firmly healed.

I have given (p. 418) an instance in which, in 1895, after dividing two bands in a case of acute intestinal obstruction admitted on the fourth day, I drained the intestines by a Paul's tube tied into the worst of three gangrenous patches present. Vomiting with some tympanites continuing, I had an ounce of castor oil given by the tube. Abundant flatus was soon passed per rectum, and recovery steadily followed. Owing to the patient's brutish behaviour—he was discovered on the point of drinking his urine, he took solid food from other patients, and five days after the operation pulled the tube out of the bowel—a fæcal fistula followed, which I closed by the method given at p. 418.

Nelaton's Operation. Right Iliac or Inguinal Enterostomy.

Operation.—A horizontal incision, about two inches long, is made a little below the centre of a line drawn from the umbilicus to the right anterior iliac spine, or one lower down parallel with the outer part of Poupart's ligament. The cæcum having been made out to be empty, the relation of this to the distended coils which are present in the wound should, if feasible, be made out, so that the small intestine may be opened as low down as possible (*vide* p. 344). In making the opening those details already fully given (p. 346) must be followed.

B. Conditions chiefly affecting the Large Intestine and bringing about Chronic Intestinal Obstruction.—Enterostomy under these conditions has been already referred to in the account of colotomy.

Given a case in which the obstruction is somewhere in the large intestine, where, though perhaps the onset has been given as acute, the surgeon is clear, from the age, history, &c., that it is really a case of acute or chronic mischief, the following course should be followed,

An incision being made below the umbilicus, the surgeon examines first the sigmoid and then the large intestine up to the cæcum. The obstruction having been found, the surgeon must deal with it according to the patient's condition and his own surroundings. Many will prefer to close the median incision and perform a lumbar colotomy on the right or left side, according to the position of the obstruction. Others will bring, if possible, the cæcum or sigmoid or transverse colon into the median incision and establish the artificial anus there. I have stated at p. 118 my objections to thus drawing a piece of rather fixed large intestine up into the middle line. For my own part, having made out the obstruction, I should prefer to deal with it as follows, mentioning only the more usual sites (footnote, p. 118). If, as is most frequent, it is in the sigmoid, I should close the median incision, and bring out the sigmoid with the obstruction, and keep the loop outside with a rod and sutures (p. 126), and open it at once or a little later. This would give the opportunity of resecting the affected loop later on. Another course would be to close the median incision and perform a left lumbar colotomy. If the obstruction was in the splenic flexure I should try to bring the transverse colon out into the top of the median incision prolonged upwards, and open this intestine (p. 139). If the disease is in the hepatic flexure, a right lumbar colotomy would be indicated, the median wound being closed. If lower down, the cæcum must be opened. I have pointed out at p. 138 the chief objection to this step, viz., the liquid character of the escaping fæces, but a valvular cæcostomy minimises this trouble, and an appendicostomy may do the same (*vide* p. 140). If the growth is found to be irremovable and placed above the middle of the sigmoid flexure, some form of ileocolostomy should be preferred to a permanent artificial anus; but if the condition of the patient and that of the distended intestine are bad, a fæcal fistula may have to be established.

Operation.—Wherever the opening is made, the details already so fully given at pp. 120 and 126 will suffice.

UNION OF DIVIDED OR INJURED INTESTINE BY SUTURE OR OTHERWISE.

By Suture.—The methods devised are very numerous; most have quickly become obsolete. I shall only refer to a few here, as those with which I am personally acquainted, and those which will be found, on the whole, the simplest and the most efficient. And first as to the essentials of a good intestinal suture. The chief are—

(1) It must be simple, one that can be rapidly introduced, and one which will effectually close the wound, and hold it securely until the parts are firmly healed. It must also be hæmostatic. (2) In its introduction attention must be paid to the following. (a) The sutures, when applied from and knotted outside, must not pass through the mucous coat, otherwise they may draw septic fluids from within the bowel to the peritonæal surface. (b) When the sutures pierce all the layers of the intestinal wall, the knots should be upon the mucous surface, and none of the sutures when tied should be visible upon the serous surface, but should be entirely hidden by the inversion which they

should produce. When these precautions are taken, there is little risk of infection of the peritonæum by fluids travelling by capillary attraction along the sutures from the interior of the bowel.

In any case each suture should take a sufficiently firm hold, so as not to cut out when any strain is put upon it,—*e.g.*, by peristalsis or distension. Sero-muscular stitches are very apt to tear out when the tissues become inflamed and softened after three or four days, and the submucous coat cannot be included with any certainty or even probability, for it is much thinner than the intestinal needle in common use. The submucous and mucous coats are far more fibrous and durable than their outer coverings; therefore it is necessary to pierce them in order to obtain a firm and lasting hold for the sutures. The success of the

FIG. 98.

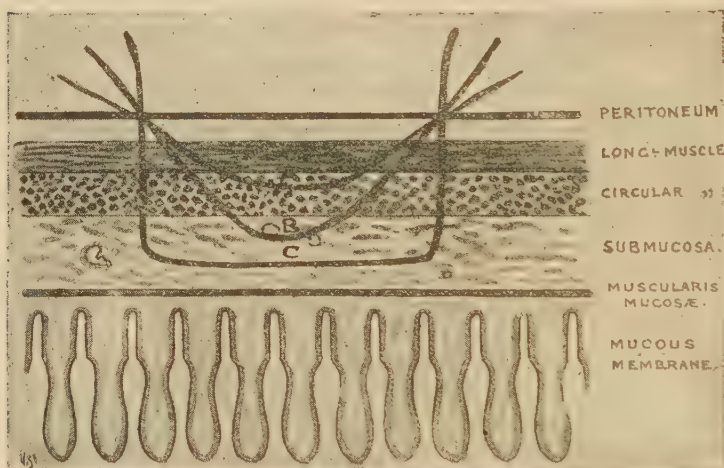


Diagram to show good and bad methods of inserting sutures.

- A, Bad method. Suture holds only muscle, and is liable to cut out.
- B, Not good method; too little hold of submucosa, and too sloping.
- C, Proper method; takes a good hold of the tough submucosa. (Greig Smith.)

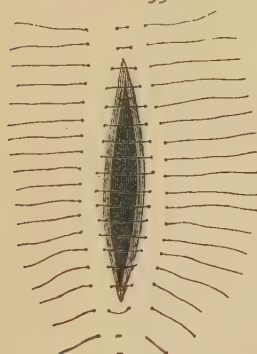
The submucosa is shown to be far too thick here.

Maunsell and Connell sutures is chiefly due to the fact that they are passed from the inside through the inverted edges of the bowel. They are also tied within the lumen, and this determines capillary drainage inwards towards the knots, and facilitates the discharge of the threads into the intestinal canal without risk of peritonæal infection. It is more than probable that many so-called sero-muscular sutures pierce the mucosa of the small intestine. (c) Attention must be paid to the risk of sloughing along the edges if too many sutures be used, or if they be tied with strangling tightness. (d) The material used must be aseptic and sufficiently durable. Fine silk, or Pagenstecher's thread should be used for the sero-muscular suture, and catgut for the deep or penetrating one. The sutures are best introduced by the ordinary fine round sewing-needle, the aperture of which is at once plugged by the thread which follows, while its round shaft does not wound small

vessels like the ordinary triangular-pointed needle, which is not needed here owing to the readiness with which the intestinal coats are penetrated. Fine curved needles must be used to introduce the sutures from within. It will save much time to have several needles threaded and secured on aseptic lint in carbolic acid lotion. If possible, as many should be threaded as there will be sutures, both continuous and interrupted. These should be kept apart.

Chief Varieties of Suture.—(i) **Lembert's Suture** (Fig. 99).—The value of this depends on the fact that it fulfils in an eminent degree the condition first pointed out by the introducer, that to obtain union of an intestinal wound it is absolutely needful to bring and keep the serous surfaces in contact. Each suture should be inserted not less than one-third of an inch from the cut edge, and run along deeply in the muscular or in the submucous coat; it is then made to emerge

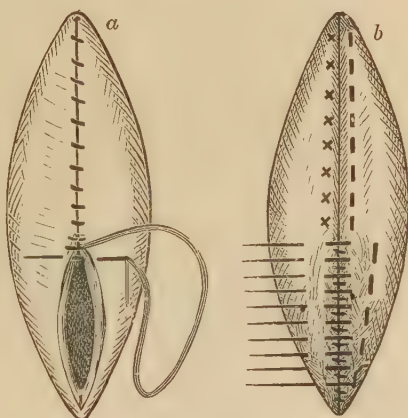
FIG. 99.



Lembert's suture as used by Sir W. MacCormac in two successful cases of intraperitoneal rupture of the bladder.

A continuous Lembert's suture is better.

FIG. 100.



To the left the continuous suture is shown. The right-hand figure shows the continuous one inverted and buried by a row of Halsted's sutures. (Jessett.)

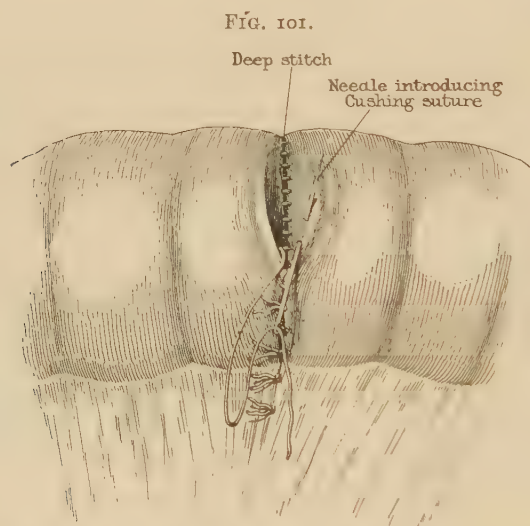
just wide of one cut edge, reinserted just beyond the opposite edge, then at once made to travel between the coats and to emerge as before.

A continuous suture inserted in the same way as Lembert's interrupted stitch is more often used now, and has the advantage of being far more quickly applied. The objections that have been brought against it are chiefly :—

(a) If one part of it becomes loose, the whole is liable to become insecure. (b) It is difficult to secure even tension all along the line, unless care is taken to keep the thread always taut. (c) If the bowel contract, the whole suture may become loosened, and the wound gape; this calamity is far more likely to occur, because the suture cuts its way out, for it may not get a firm enough hold to keep the parts in apposition long enough for good union to occur. Therefore few surgeons now trust to this stitch alone, and most prefer to use a deep suture, which pierces the whole thickness of the wall.

The continuous suture shown in Fig. 100, *a* is even less to be trusted, but if reinforced by Lembert's or Halsted's sutures, it may be found useful in cases of perforation of the intestine or rupture of the urinary bladder.

(ii) **The Czerny-Lembert Suture.**—This is only Lembert's suture reinforced by a deep row in order to bring together accurately the margins of the mucous membrane, as well as to approximate more perfectly the serous surfaces. The introduction of the first or deep row is shown in Fig. 122. It will be seen that these sutures are knotted within the lumen of the bowel, which is a safeguard against infection. The mucous membrane being loose, is very apt to prolapse and evert, and this may lead to approximation of epithelial surfaces and weak union, although this danger may be lessened by excision of some of



Cushing's sero-muscular suture (modified from Dowd, *Ann. of Surg.*).

the mucous membrane. It is difficult to prevent a leak at the mesenteric border by this method, and the hold obtained by the deep stitch is not so secure as the one gained by a suture which pierces all the coats. Most surgeons have given up the Czerny-Lembert suture for simpler and safer methods.

Mr. Stanmore Bishop (*Lancet*, 1903, vol. ii. p. 350) mentions a fatality from obstruction due to œdema of the diaphragm that is apt to form when the Czerny-Lembert method is used.

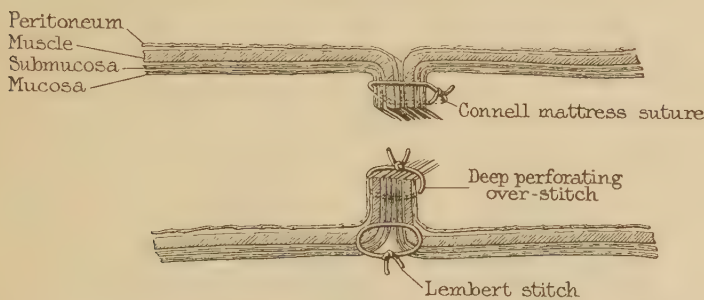
(iii) **Halsted's Quilt or Mattress Suture** (Fig. 100, *b*).—The distinguished surgeon who introduced this method claims for it that (1) it is so safe that a single row of it will suffice; (2) it constricts the tissues less than Lembert's sutures; (3) it tears out less readily if submitted to tension.

(iv) **Cushing's Continuous Stitch** is simpler, more expeditious, and buries itself better, although it is not so firm as Halsted's interrupted suture; the needle is passed in a direction at right angles to

the axis of the bowel, and picks up the serous and muscular coats (*vide* Fig. 101).

(v) **Maunsell and Connell's Stitch.**—These pierce all the layers of the intestinal wall, and thus tend to secure a firm union, arrest hæmorrhage, and prevent the ends parting, which is the commonest

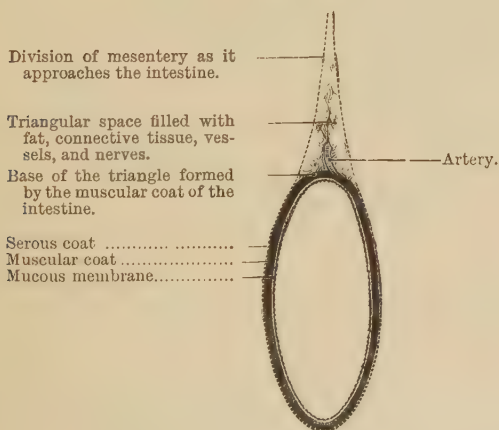
FIG. 102.



Longitudinal section of intestine, showing some methods of suturing it.

cause of death after anastomosis. In all of them the sutures are knotted internally to prevent the leakage at the knot, which is the commonest site of leakage in other methods according to Chlumsky's experiments. Connell's stitch differs from that of Maunsell in that it is not an over-stitch, but a mattress one, which secures more inversion

FIG. 103.



Section through jejunum. (MacCormac.)

of the edges, and is more hæmostatic; experience has shown that it does not lead to sloughing of the edges (*vide* Fig. 102).

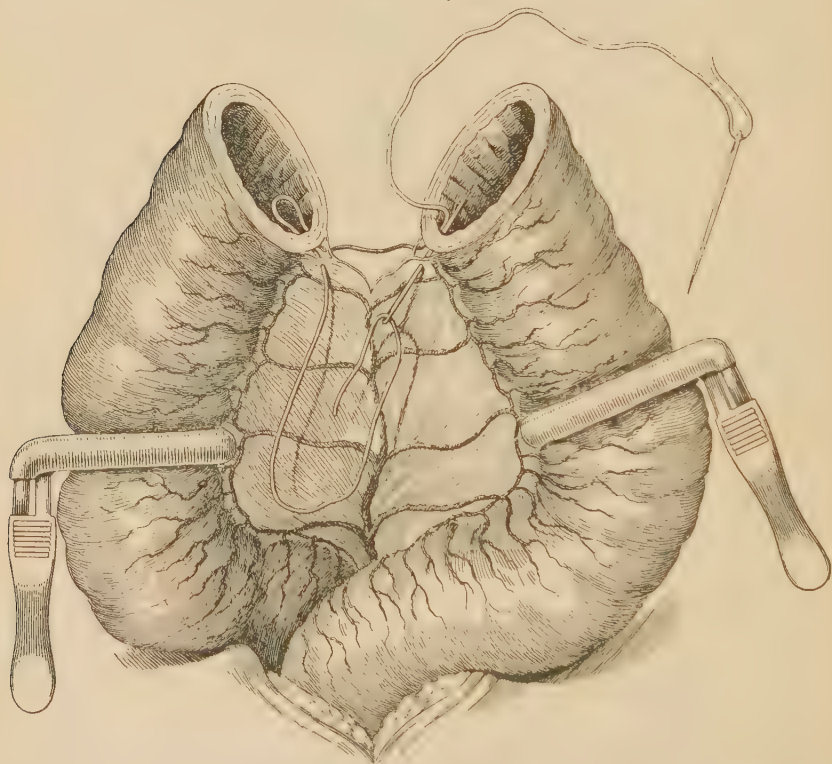
Continuous perforating sutures are the best for arresting hæmorrhage, and for this purpose the turns should not be more than one-eighth of an inch apart.

(vi) The plan adopted by most English surgeons at the present day is to make use of a double line of suture: an inner continuous one of

catgut or silk, taking up all the coats of the bowel; and an outer row, consisting of a second continuous sero-muscular one of silk or Pagenstecher's thread. Which of the above methods will be finally judged to be the best is uncertain.

In performing the operation the following points require especial attention: (1) The sutures should be inserted about one-eighth of an inch from each other. (2) Adequate inversion of the edges and contact of the serous surfaces must be secured, this being effected by entering

FIG. 104.



Mattress suture at the mesenteric border. The triangular interval is abolished, and the edges of the intestine are inverted by the thread, which is knotted on the mucous surface. (After Lee, *Ann. of Surg.*, vol. xxxiii., 1901, p. 28.)

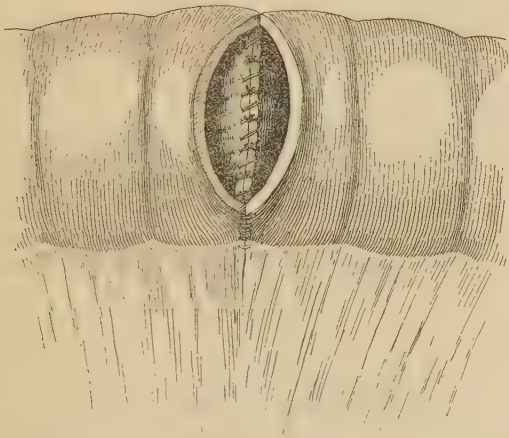
the sero-muscular sutures at a sufficient distance from the edges, and holding the thread always taut, or, if interrupted sutures be used, by an assistant aiding the inversion by dipping in the surfaces just before each batch of sutures is tied. Inversion is also obtained by holding the edges together in this position, and passing and tying the sutures from within, as in Maunsell's and Connell's methods. The forceps of Allis, O'Hara, or Horsley may serve the same purpose as the suspending or temporary retaining sutures of Connell and Maunsell.

However circular enterorrhaphy be employed, close attention must be paid to these points shown in Fig. 103. The first is the triangular space which is formed by the divergence of the two layers of the

mesentery at their junction with the bowel. This is occupied by fat, connective tissues, vessels, and nerves. In the suturing of resected intestine this space *must* be obliterated, as shown in Fig. 104. The thickness of the bowel is also to be noted. The muscular layer is (Fig. 103) comparatively thick, and sutures here are easy of introduction. In the ileum this coat would be much thinner and the whole tube smaller.

The Operation.—The mesentery having been tied off up to the level of the portions of bowel to be united, and the growth or damaged bowel having been clamped and excised, the ends are thoroughly cleansed, and gauze packings are used to isolate them. A mattress suture of catgut or silk is inserted near the mesenteric border and tied within

FIG. 105.

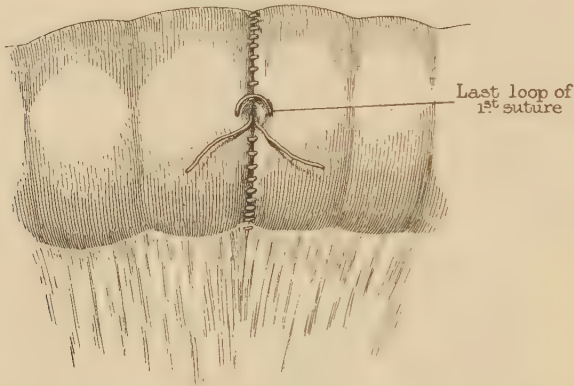


Appearance of the intestine when two-thirds of the first row of sutures have been tied. Dr. Dowd knots the thread after every third insertion of the needle to prevent narrowing of the lumen. Only one of the threads leading from the knot to the needle is cut, so that a fresh suture is not required if the original one is long enough. This precaution is not necessary if the thread is always kept taut. (After Dowd, *Ann. of Surg.*, vol. xxxvi. p. 54.)

the bowel, as shown in Fig. 104. This stitch obliterates the mesenteric triangle, where the intestine is uncovered with peritonæum, and also inverts the edges of the bowel. The clamp forceps are held close together by an assistant or locked together (Carwardine's forceps, *vide* Fig. 138), and one end of the long mattress suture is used as a continuous stitch to unite the edges which lie in contact, and are inverted. The thread passes through all the coats and secures a good bite, with an interval of one-eighth of an inch between the sutures, which pass over the free edges. It is easy enough to place the first half or more, but towards the end it becomes more and more difficult to produce proper inversion. When two-thirds of the circumference of the bowel has been sewn by means of one end of the suture, the other end is used to close the remainder, so that the finishing point may be well away from the mesenteric border, and, therefore, more easy to see and invert sufficiently. Both ends should terminate on the mucous surface, so that

they can be tied together so as to leave the knot within the lumen of the bowel, as shown in Figs. 106, 107. To secure proper inversion with

FIG. 106.



Both ends of the continuous deep suture are hooked out; the ends are to be pushed into the lumen of the bowel after the knot is tied firmly. (After Dowd, *Ann. of Surg.*, vol. xxxvi. p. 56.)

FIG. 107.



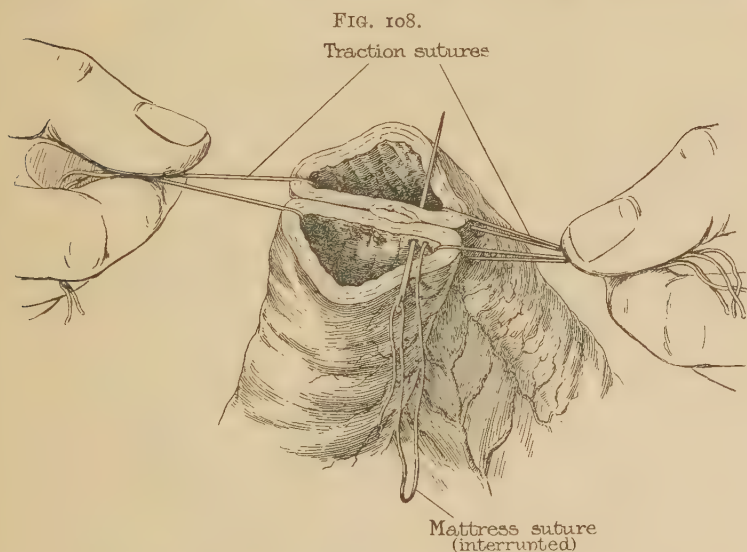
Connell's method of tying the last knot upon the mucous surface. (After Lee, *Ann. of Surg.*) Both ends of the continuous deep suture are drawn through the suture line, some distance away from the finishing point, by means of a needle and thread. When the knot is tied the ends immediately disappear into the lumen as the bowel regains its circular shape.

the last few sutures the right-angular perforating stitch recommended by Lee and Horsley may be found very useful (*vide* Fig. 112, B).

A continuous Lembert or Cushing suture is now rapidly inserted after moving the clamps further away from the suture line, so that inversion may be more readily accomplished (*vide* Fig. 101, p. 354).

The mesenteric cleft is then sewn up, and a graft of mesentery or of omentum if available may be fixed over the line of suture in some cases, or a few additional Lembert sutures may be used to strengthen any weak spot. The intestine and mesentery are thoroughly cleaned, and the intestine replaced within the abdomen after the gauze packs have been removed. Firm union is most likely to take place when the joined intestine is completely surrounded by peritoneal surfaces which soon adhere to and protect the line of suture. When this desirable protection is not available, failure of union and the formation of fistula are not uncommon. For this reason it is rarely wise either to leave sutured intestines exposed in the wound, or to insert a drain quite down to the suture line.

Connell's Method of End to End Union.—In this method, which has



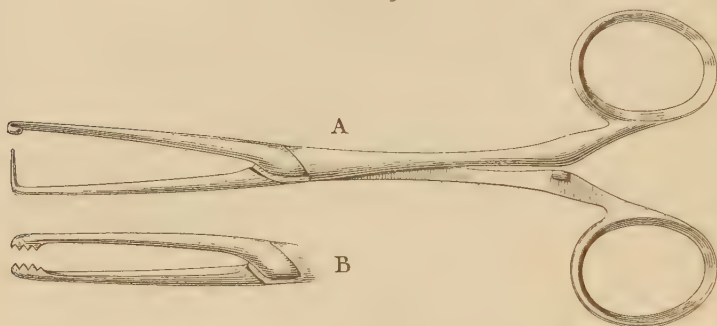
Connell's method of end to end union. (Modified from Connell, *Medicine*, April, 1901.)

been largely and successfully used by many American surgeons, the edges are joined together by a single row of sutures, which pierce the whole thickness of the intestinal wall, and thus secure a firm hold. The stitches are "square" or mattress sutures, which do not pass over the edges, and, therefore, they secure more inversion and better serous apposition than the usual circular or over-stitch provides (*vide* Fig. 102); but the latter brings the edges into better apposition.

All the knots must lie upon the mucous surface, to lessen the risk of sepsis travelling towards the peritonæum, and to facilitate the early discharge of the sutures into the lumen without the same amount of risk of sloughing and leakage as if the knots were tied upon the serous surface. It has been demonstrated that fluids travel towards the knots or suture ends, which should, therefore, be within the bowel (Chlumsky, *Beitr. Klin. Chir.*, B. xxv. H. 3). It will be noticed also that very little, if any, of the suture need show upon the serous surface, so that the danger of peritonitis is lessened, and adhesions diminished.

For these reasons, it is not necessary to reinforce or bury the suture by means of sero-muscular stitches; thus time is saved, and the risk of the formation of a diaphragm is smaller. The inverted edges are

FIG. 109.



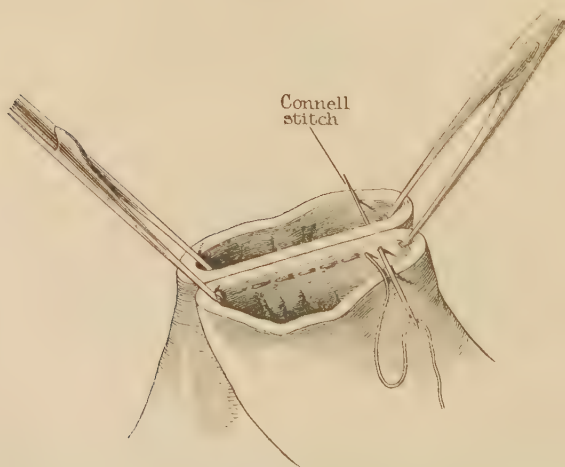
Allis' forceps.

A. The tenaculum or basting forceps. B. The rat-toothed forceps. The teeth are at the side. These forceps are used for inverting the edges during the insertion of the last few sutures. (After Allis, *Ann. of Surg.*, vol. xxxv. p. 353.)

only compressed at intervals, so that their nutrition is not seriously interfered with. Either continuous or interrupted sutures may be used.

Mr. Bishop, in 1883, devised this form of interrupted suture, and

FIG. 110.



The edges are held taut and inverted by a pair of basting forceps. A continuous Connell stitch is being introduced. (Modified from Allis, *Ann. of Surg.*)

Dr. M. E. Connell, in 1892, introduced a similar but continuous one. Dr. F. G. Connell (*Journ. Amer. Med. Assoc.*, October 12, 1901, p. 953; *Amer. Med.*, January 24, 1903) prefers interrupted sutures, because he considers them to be more secure and without risk of contracting the orifice. A continuous one is more quickly applied, and the risk of

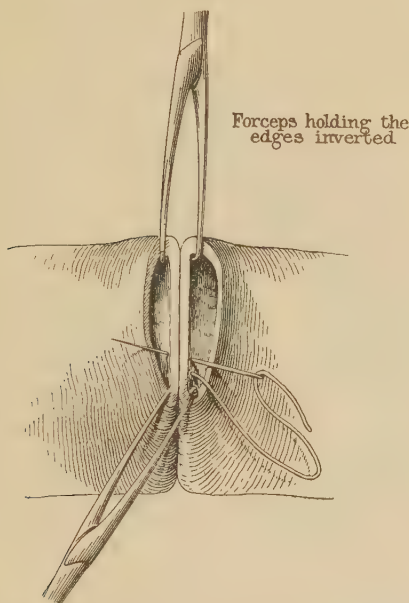
slipping and pursestring narrowing of the lumen has been exaggerated, and it can be avoided by taking an occasional back stitch.

A continuous suture prevents dilatation of the intestine at the circle of union, and thus acts as a splint which protects the union from the stretching effects of intestinal distension. Interrupted sutures do not prevent stretching between the individual stitches.

If a continuous suture tear out at one spot, the whole circle of union is endangered, but the risk of this accident is less with the Connell suture than with the usual circular stitch, which takes a poorer hold.

It has been shown by Dr. Horsley and others that the Connell suture holds very securely, especially during the critical time for

FIG. III.



Advanced stage of suturing with the aid of Allis' forceps.
(Allis, *Ann. of Surg.*)

intestinal sutures, which often slough out and allow leakage on the third or fourth day. The union is more certain and secure than that obtained with mechanical contrivances.

Clinically leakage rarely occurs with Connell's method. Connell (*Amer. Med.*, vol. v. p. 135) gives a table of 64 operations performed by different surgeons by his method. Of the 21 deaths, only one was due to leakage; all the others were due to shock, previous peritonitis, &c.; In animals Ferguson found that out of 300 anastomoses performed in this way by post-graduate students the mortality was only 3 per cent. (*Ann. of Surg.*, vol. xxxiv, 1901, p. 846).

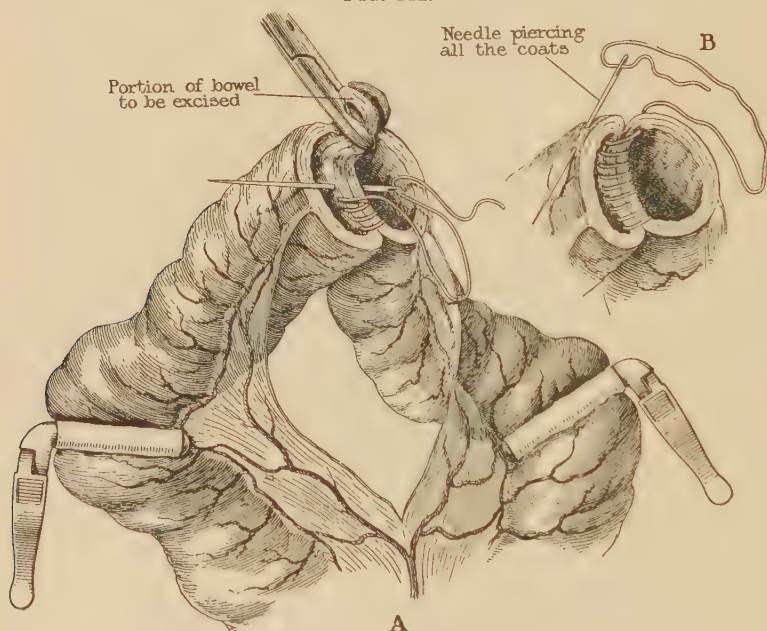
The Operation.—The intestine is clamped at some distance away from the sections, and the exposed ends are thoroughly cleansed as usual. Lee's mesenteric stitch is inserted to secure efficient inversion and obliteration of this dangerous area (Fig. 104). To facilitate the

introduction of sutures, the edges of the intestine are kept taut and inverted by means of traction sutures or tissue forceps (Figs. 108 to 111).

This object may also be attained by inserting two mattress sutures on either side of the mesenteric border, and at a distance of one-third of the circumference of the bowel from one another. The ends are left long and used for traction during the introduction of sutures between them. Each suture should take a bite of one-eighth of an inch, and the same distance should separate it from its neighbours.

Another mattress stitch is placed at the remaining point of trisection of the circumference, and used for traction in a similar way, while the second third of the circumference is sewn. All the long ends are then

FIG. 112.



Dr. J. S. Horsley's method of end to end union.

A. A semilunar piece of each end is held by the forceps and excised, so that the circle of union may be enlarged to counteract any subsequent narrowing. (After Horsley, *Ann. of Surg.*)

cut off. Personally I prefer to use a continuous suture, and to secure inversion by means of tissue forceps. So far the sewing is easily accomplished, but the remainder is more difficult, for towards the end the edges cannot be held in contact and inverted during the insertion of the needle unless this is done from the serous surface.

When this difficulty arises, the needle should be passed out on to the serous surface on one side of the wound, then across the gap to take a bite of all the layers of the other margin, as seen in the figure (112, B). This process should be repeated on the other side and continued alternately on the two sides until the circle is completed. By adopting this method only one insertion is required to secure each bite, and only two to complete each square stitch. The continuous stitch can

be held taut all the time, for there is no need to pass the needle from the mucosa, and therefore no object in keeping the wound open. This stitch differs from that of Cushing by piercing all the coats, and it therefore secures a far firmer and more permanent hold. When the circle has been completed, the thread should be made to terminate upon the mucous surface, where it can be tied to the tail thread of the first knot in one of the ways illustrated in Figs. 106, 107.

Horsley does not place the last knot within the lumen of the bowel, but, after completing the circle, he continues his suture for a few turns as a sero-muscular one. This serves to protect the weakest spot of the union, and is easier and quicker than placing the knot upon the mucosa. The last Cushing suture is taken in reverse direction, so that the knot can be buried between the serous folds.

Few English surgeons like to dispense with a sero-muscular reinforcing suture, and the danger of the formation of a diaphragm is small in the human subject, although it is considerable in experimental work upon intestines of small calibre. I always prefer to add a continuous Lembert or Cushing suture. Horsley excises a semilunar piece from each of the intestinal ends in order to enlarge the circle of union, and thus avoid the risk of stricture formation (*vide* Fig. 112, A). This is rarely necessary in the comparatively large intestines of man. Horsley has used his method upon 19 dogs without a death or any obstruction.

The advantages and disadvantages of circular enterorrhaphy are given at p. 380, where this method of uniting intestine is compared with other means, such as Murphy's button, and Mayo Robson's bone bobbins.

MODIFICATIONS OF CIRCULAR ENTERORRAPHY; AIDS TO ITS PERFORMANCE OR MEANS OF REPLACING IT.

Owing to the objections which some have raised against circular enterorrhaphy, other methods have been invented. I propose only to describe those which have stood the test of successful trials in the human subject, as well as given good results in animals.

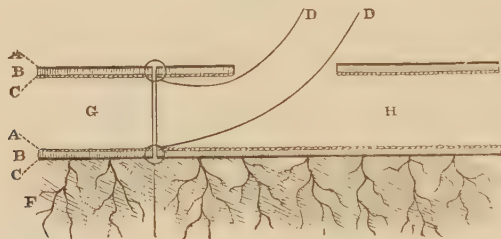
Method of Maunsell.*—This modification of circular enterorrhaphy is based on the fact that, when Nature performs enterorrhaphy successfully, she does so by the process of invagination, adhesive inflammation, and sloughing. The two ends of the bowel† are brought together by

* H. Widenham Maunsell, late Lecturer on Surgery, Otago University (*Amer. Journ. Med. Sci.*, March, 1892). The inventor used his method first as long ago as 1886, after resection of the small intestine "for cancer" in a child aged 6. The child sank on the sixth day; at the necropsy the segment of the intestine showed no evidence of leakage. Dr. Wiggins (*New York Med. Journ.*, Dec. 1, 1894, and in his pamphlet, for which I am indebted to him) relates a successful case in which he resected six inches of ileum for contusion and perforation, uniting them by this method. The patient was well ten months later. Dr. Wiggins mentions a case of Dr. Harley's (*New York Med. Journ.*, vol. lvi. pp. 302 and 464) in which this method was also successfully employed for the resection of a double intussusception and carcinoma.

† The preliminary steps as to clamps, &c., would be the same as those given at p. 388.

two long temporary sutures passed through all the coats of the intestine (D D, Fig. 113), one being placed at the mesenteric junction, and the other exactly opposite. These sutures secure the peritonæal covering of the intestine, and serve later to effect invagination. A slit about an inch and a half long having been made in the long axis of the free border of the proximal part of the intestine, about an inch from the divided end of the gut, these two long sutures are passed up through the lumen of the bowel and out of the slit; when pulled upon, the smaller or distal end of the bowel will be invaginated into the larger, and drawn out of the opening in this (Fig. 114). From this figure, which shows the relative position of the layers invaginated, it will be seen that the peritonæal surfaces are in accurate apposition all round. While an assistant holds the ends of the temporary sutures up and apart, the surgeon passes a long, fine, straight needle, carrying stout horsehair or very fine silkworm gut, through both sides of the bowel,

FIG. 113.



This and the next three figures show Maunsell's modification of circular enterorrhaphy. A B C, Peritonæal, muscular, and mucous coats. F, Mesentery. D D, Temporary sutures by which the lower is invaginated into the upper end; they are seen to emerge through a slit in the latter. (From Walsham's *Surgery*, copied from Maunsell, *loc. supra cit.*)

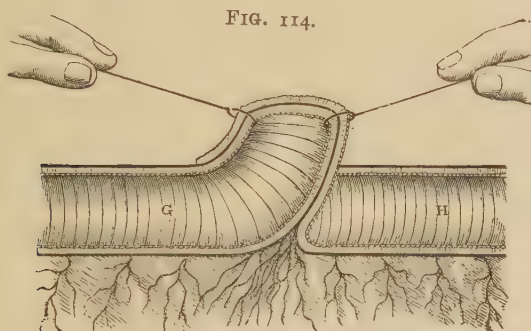
taking a good grip (a quarter of an inch) of all the coats (Fig. 115). The suture is then hooked up from the centre of the invaginated gut, divided, and tied on both sides. *In this way twenty sutures can be rapidly placed in position with ten passages of the needle.** The temporary sutures are now cut off short, and the invaginated gut is then pulled back.† Finally, the longitudinal slit in the gut is well turned in, and closed by a Lembert's continuous suture, and painted and dusted as above. The appearance of the gut is now as in Fig. 116; the serous surfaces should be in accurate apposition, and all the knots

* Mr. Stanley Boyd introduced here two or three modifications of this important stage, which may be useful. Finding that time was lost in drawing up the loops from the lumen of the bowel, and in selecting corresponding ends, he passed many of these sutures not across the lumen of the bowel, but through only two walls, and tied the sutures as they were inserted. He found that great care was needed to ensure that the cut edges of the peritonæal coats were equally drawn up, and that each stitch passed a good quarter of an inch below them, for the mucous membrane tends to prolapse and to conceal the peritonæal edges, which are of chief importance.

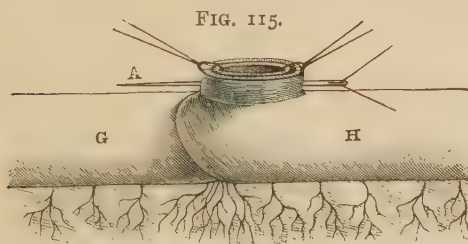
† If now there is any doubt about the line of suturing, a few Lembert's sutures should be added externally, especially about the mesenteric junction; or an omental graft (p. 400) may be added (Stanley Boyd, *Med.-Chir. Soc. Trans.*, vol. xxvi. p. 345).

inside the bowel. Dr. F. H. Wiggins (*loc. supra cit.*), comparing this method and Murphy's button, pointed out the following as requiring careful attention when this method is employed: 1. The mesenteric border must be carefully approximated. 2. The sutures must be interrupted, and not placed too near the edge of the intestine; they should be placed a quarter of an inch from it, at least. 3. They must not be tied too tightly. 4. Too much force must not be used in reducing the invagination, or the sutures may cut out. 5. In closing the longitudinal incision, too much of the edges must not be turned in, or a contraction may result.

While this method is less alluring than Murphy's button, and cannot



G, The interior of the lower segment which is invaginated into and through the opening in the upper segment.*



A, The needle introducing two sutures by a single transit. G and H as before.

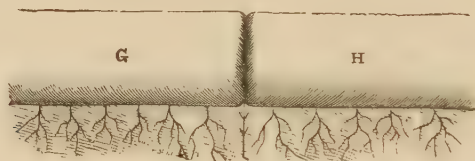
be used so rapidly, it has certain **advantages** over it which it shares with circular enterorrhaphy, and certain peculiar to itself. Thus, it needs no mechanical device, which may not be at hand just when wanted. It requires only a few needles, silk or durable catgut. Thus, in Dr. Wiggins's account of his own case, in which he resected six inches of the ileum for contusion and perforation, uniting the ends by Maunsell's method, he writes (*loc. supra cit.*): "The urgency of this case was great. The patient was in a country farmhouse. The operation could not have been safely delayed one hour longer than it was; consequently there was no time to procure mechanical devices from the

* Mr. Stanley Boyd in his case made the incision in the distal end, and invaginated, with a little difficulty, the upper larger into the lower small end.

city. A few instruments, a paper of ordinary sewing-needles—milliners' No. 6—and some iron-dyed silk were easily procured, and the operation was promptly performed, and the patient's life saved." Dowd (*Ann. of Surg.*, 1902, vol. xxxvi. p. 47) states that 31 cases of Maunsell's operation had been reported, with only 3 deaths, but several operators had used a few reinforcing sutures. No one of the deaths was attributable to any fault in the method, all the patients dying of shock. It is probable that unsuccessful cases have not been published.

The advantages which are claimed over circular enterorrhaphy are that this modification is speedier of execution, and that it gives easier command over the hæmorrhage. A third is that, when the ends are of unequal size, they can be more readily dealt with by the invagination of this method than by circular enterorrhaphy. A fourth is that inversion of the edges is so good that no reinforcing sero-muscular stitch is required. The chief objection to be brought against it is the additional wound through which the temporary invagination has to be made.

FIG. 116.



This shows the line of junction, the peritonæum well turned in, and the sutures and knots nearly all inside the gut. One or two sutures are seen in the mesentery. G and H as before. Above H would be the longitudinal slit sewn up by a continuous suture.

Connell, Wiggins, and others have since devised other methods of attaining the same objects without having to make an additional wound, which is difficult to close satisfactorily without narrowing the bowel. Maunsell's suture, being a circular one, is more exposed upon the serous surface, and is therefore in more need of reinforcement than Connell's suture. Having compared this method with Murphy's button (p. 368), it is right that I should add that Dr. Ricketts, of Cincinnati (*Ann. of Surg.*, vol. i. 1894, p. 473), after resecting four inches of the ileum for carcinoma, on attempting "to make a Maunsell operation," found that the distal end of the gut was so fixed, it being only five inches from the ileo-cæcal valve, that more time would be consumed than was for the good of the patient. He accordingly used the Murphy's button, which took only eight or ten minutes. The patient, who had persistently refused operation, sank ten hours later. Dr. Ricketts, while "satisfied that the button was the most appropriate in this case," is "thoroughly convinced that the Maunsell operation is the one to be used in the majority of cases."

Rogers' Method of performing Enterectomy without the Aid of any Special Apparatus.—At the present time, while the best means of performing enterectomy are still *sub judice*, and as it will certainly have to be performed, under widely different conditions, in very different ways, the following deserves mention for the sake of complete-

ness. It will be found described *Brit. Med. Journ.*, 1896, vol. i. p. 903. The method consists in turning back the peritonæal coat of one end of the small intestine, suturing the muscular coat thus exposed to the peritonæal coat of the other end of the intestine, subsequently turning down the reflected portion of peritonæum over the first row of sutures, which are thus completely buried, and suturing the deep surface of the reflected peritonæum to the unreflected serous surface on the other end of the intestine. Thus a double sero-fibrous union is obtained which will unite both quickly and firmly. The inner sutures are passed through the muscular coat of one end and the muscular and peritonæal coats of the other end of the bowel, while the outer sutures include the peritonæal coats only. Each row of sutures is a continuous one. The second one, which unites the peritonæum reflected off one end of the bowel over the same coat unreflected on the other, begins by uniting the triangular gap at the mesenteric junction (a most important spot, p. 355, Fig. 103), and then travels round the bowel.

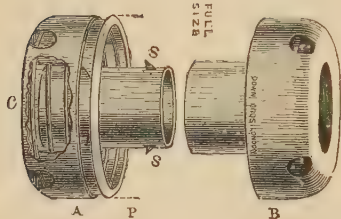
The following **advantages** are claimed by Dr. Rogers for this method: (1) It can be done with the aid of the instruments in a pocket-case, ordinary round sewing-needles being used (although curved intestinal needles are to be preferred), and with very little assistance, and is therefore likely to be of especial service in military surgery or in country or foreign practice. Yet (2) it can be completed in about half an hour, or only a little longer than the time required with the aid of such special appliances as plates, buttons, and bobbins. (3) The junction is a double sero-fibrous one, and hence, as the late Mr. Greig Smith believed (*loc. infra cit.*), will combine the maximum of rapidity and firmness. (4) The mesenteric junction can be made very firm by the apposition of the muscular coat of one end to the peritonæum of the other, and subsequent covering up of this suture by the reflected peritonæum.

The chief **disadvantage**, on the other hand, lies in the difficulty in reflecting the peritonæal coat. The late Mr. Greig Smith said: "This is not easy to do; it takes some time, and causes bleeding, which is long in stopping. Also it often causes the wounding of important blood-vessels."

Another method somewhat similar to the above is Morisani's (*Centralb. für Chir.*, 1899, vol. xxxii.). This consists in removing a strip of mucous membrane from 4 to 6 cm. wide from the distal end of the divided bowel. The proximal end is then invaginated, its serous surface thus being brought into contact with the denuded area of the lower segment. The two ends are held by two or three fixation sutures, and union completed by means of a continuous suture piercing the whole thickness of the distal segment and taking up the serous and muscular coats of the proximal segment. This method would appear to be thicker than, and quite as reliable as, Rogers' method. Campbell (*West Med. Review*, September, 1903) has revived and slightly modified this method, turning down a cuff of sero-muscular tissue 5 cm. long by gauze dissection, dividing the mucosa within 1 cm. of the base of the cuff which is on the distal end. The proximal extremity is then invaginated into the cuff and secured by two sets of sutures.

I do not recommend any of the last three methods, which have no advantages over simple end to end union by direct suture.

FIG. 117.



Murphy's button. A, Male half. B, Female half. P, Spring-flange. s s, Springs projecting through openings in hollow stem. At c, part of the cap of the small half has been cut away to show the circular spring which keeps up the pressure as the button does its work. The round holes in the caps are for drainage. (This and the next three figures are borrowed from Down's pamphlet.)

FIG. 118.



b, Puckering thread. a shows the return stitch by which the interval between the two layers of the mesentery is closed—a very important detail.

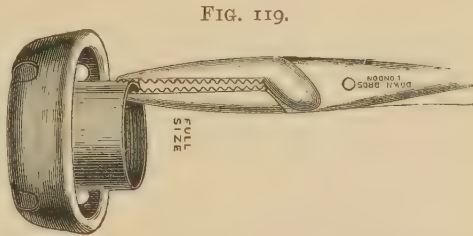
Murphy's Button (Figs. 117 to 120).—This, one of the most ingenious inventions of the last century, we owe to Dr. J. B. Murphy, of Chicago (*New York Med. Record*, Dec. 10, 1892). Its great advantage is the facility and rapidity with which end to end approximation can be effected without any sutures. The button consists of two halves. The male half has a spring flange for keeping up pressure on the intestine ends. Two springs (s s), projecting through openings in the hollow stem, act as a male thread of a screw, when the male half is telescoped within the female half of the button. When the button is used to unite resected ends of bowel* a puckering or running thread is passed round each side to and from the attachment of the mesentery, and especial care is taken to close the triangular interval which exists here (Figs. 103 and 118) by means of the return stitch. One half of the button, held as in Fig. 119, is then inserted in the intestine, and the running thread so tightened as to pucker the cut end of the intestine with sufficient closeness and tightness around the shaft of the button. The ends of the thread are then tied and cut short. The other half of the button having been secured in the opposite end of the intestine (Fig. 120), the two halves are gently pressed together, the surgeon having first made sure that both cut ends are, all along their edges, within the grasp of the button. The two halves are pressed together until it is seen that the peritoneal surfaces are held in sufficiently close and accurate contact. Dr. Murphy holds that it is needless to apply Lembert's sutures with the button between the serous surfaces, and that scarification of these is also unnecessary.†

* Its use in effecting lateral anastomosis is given at p. 406.

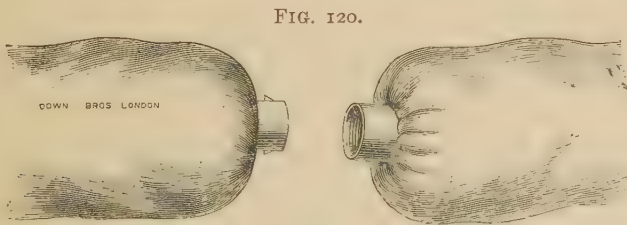
† The following precautions are given as to the button and its use. The edge of the cup should never be sharp, but possess a line of

Dr. Murphy (*Lancet*, vol. i. 1895, p. 1040) claims for his button that in resection of intestine for gangrenous hernia it has been used twelve times, with two deaths. In resection for malignant disease there have been thirty operations with seven deaths, these thirty including eight cases of resection of the cæcum, with but one death. With regard to two of the cases of fatal peritonitis, Dr. Murphy points out that in one the button was too large and fitted too tightly. To prevent tension the button should fit easily. In another case both ends of the intestine were found to be gangrenous at the necropsy. This is stated to have been due, not to the button, but to the length of time during which the intestine was clamped during the operation. Later one of Murphy's assistants collected the records of 750 cases of entero-enterostomy performed by means of the button, and found the mortality to be only 19 per cent. in all the cases, and 14.4 per cent. in the non-malignant cases (*Philadelphia Med. Journ.*, 1900, p. 1271).

The *modus operandi* of the button is based upon the following principles: (1) It retains apposition automatically—that is, without suture. Thus the danger of shock, the length of the manipulation and exposure of the intestine, the risk of infection, post-operative paralysis, and adhesions, are very greatly lessened, and an immense saving of time secured. (2) The pressure-atrophy is produced by



Showing method of holding button for insertion.*



Murphy's method of end to end approximation of divided intestine. The two halves of the button, each secured by a puckering thread, are ready to be pushed home.

elastic pressure; this being uniform and continuous, the assurance of adhesions is greater and the risk of infiltration less. It produces juxtaposition of the edges of the same coats, thus minimising the interposition of fibrous tissue, and perfecting the regeneration along the

surface. The spring must not be too stiff, or it might produce too rapid sloughing. The locking should be easy. Unnecessary handling of the buttons should be avoided. They should be left partially unscrewed until wanted for use.

* The male half of the button is held in the same way. The figure representing the forceps holding the male half of the button has been omitted, as it shows the forceps in a wrong position. Mr. Cathcart, of Edinburgh, has kindly drawn attention to this point.

line of union. As a result, the union is accomplished with the smallest possible cicatrix, and therefore must yield the least contraction of any operation. Believing that he had absolutely established the above, Dr. Murphy claimed that his button attained the best results in intestinal approximation because it best attained the following ends: (a) Accurate contact of surface. (β) Speedy and permanent adhesion of the approximated surfaces. (γ) An opening sufficiently large for immediate purposes. (δ) A cicatrix that will not contract harmfully; the formation of a diaphragm is very rare after the use of the button. (ε) The accomplishment of all these in the most *simple* and *rapid* manner. To these may be added that the button is especially suitable when speed is imperative, and when the anastomosis has to be made in the depth of a wound, because it is not possible to bring the intestine outside or even well into the wound. I found the button very useful in enabling me to join the ileum to the adherent and atrophied ascending colon after resection of the cæcum for multiple fistulæ due to tuberculous disease; the patient did well.

Objections.—Dr. Murphy's method is so alluring in its ingenuity, the simplicity and readiness with which it can be applied are so evident, that there is some danger of its **disadvantages*** being lost sight of. The following appear to me to be established:

(1) Contraction of the orifice.† When the *modus operandi* of the button is considered this risk must always be remembered. In the words of an American surgeon who has taken much practical interest in intestinal surgery (Dr. McGraw, of Detroit), "in the operation by Murphy's button, the button becomes detached by crushing the rim of tissue around the opening of communication until it sloughs and gives way, leaving behind a granulating wound, disposed to close after the nature of such wounds" (*Ann. of Surg.*, vol. ii. 1893, p. 315). A case of Prof. Keen's of ileo-colostomy, for carcinoma of the colon, by means of the button, is an instance of the truth of the above:

The button had been passed on the twelfth day, "together with a slough consisting of the rings of tissues between the two halves of the button. The patient died very suddenly of a perforating ulcer of the colon, forty-seven days after the operation, and the necropsy showed that the opening had already contracted to one-half of its original diameter.

Prof. Keen considers the possible contraction of the anastomotic opening "the pivotal point upon which rests the utility of the button."

Dr. Dawbarn, of New York, once a strong advocate of vegetable plates in intestinal surgery, had earlier (*Ann. of Surg.*, vol. i. 1893, p. 155) expressed a fear which this case of Prof. Keen's proves to have been well grounded: "In performing cholecystenterostomy it" (the button) "really seems an ideal plan; but upon stomach and in uniting bowel to

* Dr. Murphy, in a very interesting paper on "Operations with the Murphy Button" (*Lancet*, vol. i. 1895, p. 1040), makes, I think, too light of these. Several of his conclusions as to contraction of the scar left by the button, fæcal impaction, and sloughing, are, it seems to me, not justified by the published cases (*vide infra*).

† Dr. Murphy (*loc. supra cit.*) states first amongst the conclusions at which he has arrived—"The cicatrix produced with the button does not contract." No mention is made of Prof. Keen's case given below.

bowel, because of the primary small calibre of the new opening (still further to be reduced with time), I venture to predict a justified lack of acceptance by the profession." The following case of Dr. R. Abbe, of New York (*Ann. of Surg.*, April, 1895), shows that even after cholecystenterostomy such stenosis may follow as to prevent fluid contents, such as bile, from passing:

About a year before, Dr. R. Abbe had opened the gall-bladder, establishing a fistula in a woman who had cancer involving the head of the pancreas and first part of the common duct, causing obstruction and distension of the gall-bladder. The patient's condition having greatly improved in six weeks, Dr. Abbe established an anastomosis between the gall-bladder and duodenum with a Murphy's button. This was passed on the twelfth day. The patient remained in excellent health for eight months, when symptoms of gall-stone colic recurred, making it probable that stenosis was taking place. The symptoms returned, and the patient died in the third attack with cholæmia and convulsions. The opening created between the gall-bladder and duodenum had become absolutely closed by cicatricial contraction ten months after its establishment. The malignant disease had not invaded the anastomosed parts.

(2) Sloughing at the line of junction, and extravasation of fæces. The following case of Dr. Abbe's (*Ann. of Surg.*) is a proof of the risk of the above:

The patient was admitted with obstruction due to carcinoma of the sigmoid. Owing to the distension and the condition of the patient, a lateral anastomosis above and below the cancer was done with a button. Six weeks later resection was undertaken, owing to the pain felt locally. The anastomosed gut was resected, and an end to end anastomosis made "by a large button which fitted rather snugly in the lower end." The cancer had by this date invaded the lumbar wall. A counter-opening was made behind, and the anterior one closed. On the fourth day, fæces appeared at the lumbar wound. On the sixth day this was freely opened, and the intestine found to be sloughing on either side of the button. On the seventh day the patient died exhausted.

It is only fair to Dr. Murphy to point out that this was a very severe test for his method. The patient was "not in very good condition after the operation," and it is possible that the separation of adhesions and the extension of the growth had interfered with the blood supply of the intestine, though this is not stated.

Moreover, the button was undoubtedly a large one, for it "fitted rather snugly," and in this lies the answer to the above objection, for a button which in any degree stretches the intestine will be liable to cause sloughing opposite the outer rim. This has undoubtedly been the cause in other cases where this accident has happened.

(3) Septic peritonitis due to sloughing of the intestine over the button. When we consider that in anastomosis of the intestine we can never keep the field of operation aseptic, and that, whatever method we use, needles, sutures, buttons, &c., may all be the means of increasing sepsis, no surprise will be felt when occasionally cases are published in which septic peritonitis has followed on the use of the button. Its *modus operandi* is by setting up a limited pressure-gangrene or sloughing. In many cases this process will be limited, but it is manifestly impossible to control or limit such a process, and occasionally fatal results will be met with from this cause.

Mr. Harrison Cripps (*loc. supra cit.*) mentioned a case in which the patient died in two or three days from acute septic peritonitis due to sloughing of the intestine over the upper half of the button.

Prof. Senn speaks very strongly on this point (*Journ. Amer. Med. Assoc.*, vol. ii. 1893, p. 232): "It is impossible to effect an aseptic incision in the interior of the bowel; the dead tissue inhabited by pathogenic microbes always constitutes a source of danger. It is easy enough to produce gangrene, but we are powerless in limiting its extension in this locality. The limited area of living tissue brought in contact outside of the rings of the Murphy button will not always prove adequate in the protection of the peritonæal cavity against perforation and its immediate result—septic peritonitis. I have knowledge of a number of cases in which the parts approximated by the Murphy button were found completely separated at the post-mortem examination."

(4) Retention of the button, causing obstruction. I shall allude to cases under the heading of "Gastro-jejunostomy," where the buttons had not been passed, and the patients were not relieved. A number of similar cases have been recorded.

The following show that the button may cause fatal obstruction:

Dr. R. Abbe (*Ann. of Surg.*) has related a case of resection of the caput coli and ascending colon for cancer in a patient aged 42. An end to end anastomosis was easily made with a medium-sized, easy-fitting Murphy button. At the end of the second day there was abdominal pain, with tympanites and vomiting. Strong desire to defæcate was futile, even with the aid of a high enema. Saline cathartics were useless. On the third day after the operation the greatly distended ileum was sutured to the abdominal wall and opened. A large amount of fluid fæces escaped with great relief. The patient died on the sixth day. The necropsy showed no peritonitis, but an empty colon below the button, and a hard plug of fæces in the button, which caused complete obstruction.

Dr. Kammerer (*Ann. of Surg.*) has recorded a case in which the button caused trouble by not passing in the small intestine.

The case was one of fæcal fistula, resulting from a gangrenous hernia. Anastomosis had been made by a Murphy's button. Thirteen weeks later the button had not been passed, but could easily be reached from the fæcal fistula which still persisted. Dr. Kammerer enlarged the fistula, and after much trouble succeeded in extracting the button. The patient did well for six days, when she developed symptoms of sub-acute peritonitis and died. The necropsy showed general peritonitis. The anastomosis had separated while the button was being removed, and the sharp edges of the incision into the bowel showed that the adhesions, even after thirteen weeks, must have been very slight. Dr. Kammerer did not believe that the peritonitis was due to a separation at this point, but any other explanation for it was not apparent.

Mr. Harrison Cripps (*Brit. Med. Journ.*, vol. ii. 1895, p. 965) mentioned, in the discussion on colectomy, a case in which the patient died on the eighth day from perforative peritonitis caused by the button having become impacted six inches below the point of anastomosis, and having ulcerated through.

Mr. F. C. Wallis (*Lancet*, Dec. 5, 1903) records an interesting case of resection of a chronic intussusception of the small intestine, in which he used a Murphy button. Three weeks later the button gave rise to attacks of colicky pain, and had to be removed from the lower end of the ileum. Wallis thinks that the button used was too large, and he has not had any other trouble from the use of Murphy's button, which he has employed many times. A similar case is mentioned under "Gastro-jejunostomy."

(5) Kinking and strangulation from the weight of the button. This is rare, but a case of Dr. Abbe's is related of this kind (*Ann. of Surg.*):

Five inches of small intestine had been resected for gangrene in a hernia. The two ends having been joined by Murphy's method, the loop containing the button was

replaced, and Bassini's operation performed. Before the wound was entirely closed, Dr. Abbe looked in and noticed that the upper end of the gut was still distended. This was due to the button kinking the gut as it lay in the iliac fossa. The loop was accordingly pushed towards the middle of the abdomen, in the belief that it would settle and rest easily among the other coils. Symptoms of strangulation recurred, and forty-eight hours after the first operation Dr. Abbe reopened the abdomen and found the kink persisting, the bowel having gravitated to the lowest point in the pelvis. The patient only survived the operation a short time. It seemed that the weight of the button had given rise to the acute obstruction by sharply bending the gut. Probably this was aided by the paralysed condition of the bowel so common in these cases.

(6) Mr. Mayo Robson, in a speech at the Clinical Society, pointed out that if any error was made in applying the button, it might be impossible to unfasten it for readjustment. He stated that under such circumstances an operator, in order to set the button free, had found it necessary to excise afresh the portion grasped by the button.

(7) Another objection of a very different kind may be just alluded to, and that is, its expense, and the difficulty of always having the right size at hand. This in no way detracts from the ingeniousness of the button, nor do I bring it forward as a serious objection. It is right, however, that it should be mentioned when this mode of intestinal junction or anastomosis is fairly weighed with enterorrhaphy, Robson's bobbin, &c.; this last is, of course, required in several sizes, but, being far less expensive, will be more readily near at hand in sufficient variety.

I am well aware that these cases given above are but few when compared with the large number of brilliant successes which Dr. Murphy's button has attained. It is right, however, that they should be published, as there is strong reason to believe that the button has been used on many occasions unsuccessfully, these cases never being published. Again, it is noteworthy that the failures which have been published have occurred in the hands of most skillful surgeons. I fear that the extreme ingenuity of the button, the facility with which it can be used, may tempt men far less competent to perform operations for which they are unfitted, with results that will not be made public. König (*Centr. f. Chir.*, No. 4, 1895), I find, has expressed the same view. Thus, "The use of Murphy's button may extend the practice of resection, and so enable inexperienced surgeons to perform these operations, but this, from the patient's point of view, is rather a disadvantage than a sign of advance."

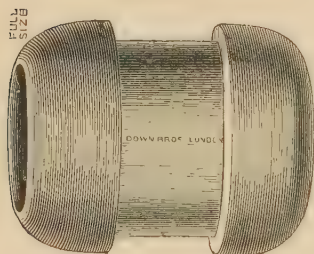
Mayo Robson's Bobbin (Figs. 121, 122, 123).—This method appears to me likely, for the present at all events, to replace all the other special couplers which have been invented to aid in the resection or anastomosis of the stomach and intestines.

Mr. Robson (*Brit. Med. Journ.*, vol. ii. 1895, p. 963) states that, after using or seeing used all the other usual contrivances, *e.g.*, Senn's plates, Murphy's button, and Paul's tubes, he has returned in enterectomy to the use of the bobbin, which "I infinitely prefer, not only on account of its simplicity and safety, but because it can be employed quickly, secures an immediately patent channel, leaves no foreign body permanently in the passage, avoids stricture by securing continuity of mucous surface,

and can be adapted to any of the operations on the intestinal canal.* Another advantage which may be safely claimed is that these bobbins are much more easily introduced when one segment of intestine, *e.g.*, the lower usually, is much narrower than the upper. Again, from their shape, they obviously will exert much less tension upon the intestinal wall and the sutures which hold them together, than the plates of Prof. Senn.

The decalcified bone bobbins were in their first issue like a cotton-reel, the rims at the ends being (Fig. 122) made larger than its centre in order to prevent the body shifting from its place until its pressure is not needed. These rims being found too prominent, the bobbin was modified as shown in Fig. 121. The following account is taken from *La Sem. Méd.*, *loc. infra cit.* (Figs. 122, 123): "It seemed that if one could secure continuity of the mucous coat across the new aperture by means of a continuous suture (Fig. 122) sewn around a tube

FIG. 121.



Mayo Robson's decalcified bone bobbin. These are made in five sizes, for junction of gall-bladder and intestine, stomach and intestine, to unite resected small intestine, colon, and rectum. The above is the size used for the colon.

without the risk of narrowing the size of the orifice, one would be able to avoid consecutive cicatricial narrowing. The union of the serous surfaces could be assured by means of a sero-serous suture made in the same way as the mucous, one or one and a half centimetres from the edges of the incision, so removing all risk of extravasation (Fig. 123). The operation is facilitated by beginning with the sero-serous suture for the posterior half of the incision, then putting in the muco-mucous for the same extent. The tube is then put in place, the muco-mucous suture next completed, and finally the anterior half of the sero-serous."

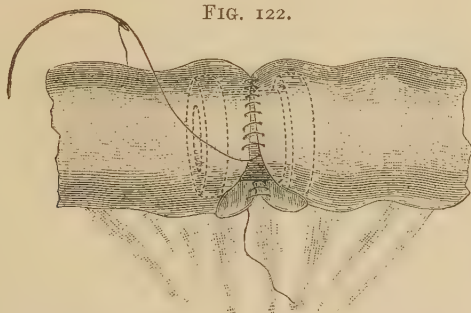
Mr. Mayo Robson (*Brit. Med. Journ.*, vol. ii. 1895, p. 965) stated that while usually employing two sutures, the mucous and serous, with his bobbin, he has not hesitated to use only one continuous stitch to unite the whole thickness of the gut where time was an object in the case. In this case he claims that the bobbin-operation can be done more quickly than that with the button, and at the same time he believes that it will give greater security against leakage and a much firmer bond of union. When the double suture is used, Murphy's button will, Mr. Robson thinks, only save three or four minutes, and he points out that his five cases of colectomy are living examples of the contrast of the after-progress of the two methods. Thus in cases i., ii., and v., where the bobbin was used, an uninterrupted recovery followed; in case iii., Murphy's button took forty-four days to pass, and caused partial obstruction on several occasions. In a list of cases which Mr. Robson prepared in order to illustrate a paper read before the Clinical Society (*Brit. Med.*

* It will be a very great gain if surgeons find, as claimed by Mr. M. Robson (*La Semaine Médicale*, 1892, p. 482), that there is one contrivance ready to their hands calling for much the same technique in all such varied operations as enterectomy, intestinal anastomosis, ileo-colostomy, pylorotomy, pyloroplasty, cholecystenterostomy.

Journ., vol. i. 1896, p. 451), the bobbin was used in seven cases of enterectomy, and out of these six recovered.*

The following **advantages** of this method have, it seems to me, been fairly established:—(1) It facilitates and simplifies circular enterorrhaphy. (2) The foreign body on which it depends is safely dissolved, instead of being left behind to come away, thus often giving rise to anxiety. (3) There is no sloughing connected with its *modus operandi*; it prevents subsequent stricture by establishing a continuous mucous canal, without the stage of healing by granulation. (4) Owing to the size of the bobbin, and there being no sloughing connected with it, the opening

FIG. 122.



The continuous muco-mucous suture. (Mayo Robson.)

FIG. 123.



The continuous sero-serous suture. Below is seen the knotted end of the muco-mucous stitch which will shortly be shut in. (Mayo Robson.)

provided is sufficient and permanent. (5) Though at present it has not been very largely used, the percentage of successes is very high. In his paper, read before the Clinical Society, Mr. Robson showed that the use of the bobbin had been attended by a mortality as low as 8 per cent. (6) Last, but by no means least in importance, is the fact that the bobbin is adaptable to a very wide range of operations. The chief **objection** to it is one common to all mechanical devices—*i.e.*, that it is not always to hand. In, however, its cheapness, its great variety of sizes, and the readiness with which it can be prepared, it contrasts

* Mr. Bowlby, in the discussion which followed Mr. M. Robson's paper, emphasised the advantage of the bobbin in securing the immediate passage of flatus and fæces.

very favourably with Murphy's button and more recent mechanical contrivances.

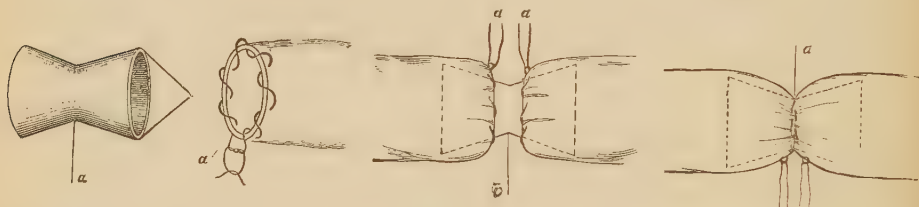
Allingham's Bobbin (Figs. 124 to 127).—Mr. H. Allingham has introduced a bone bobbin which differs from Mr. Robson's in shape and structure. It consists of two cones with the apices united in the centre (Fig. 124). They are decalcified to within about three-sixteenths of an

FIG. 124.

FIG. 125.

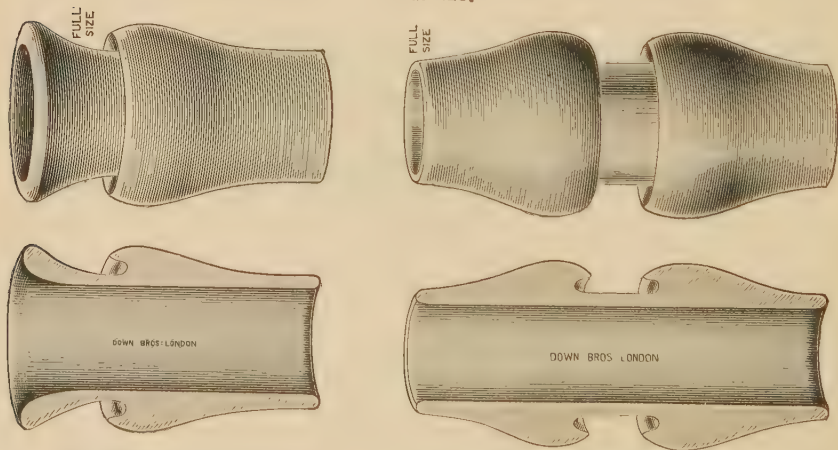
FIG. 126.

FIG. 127.



inch of their centre. The junction of the two cones is hard and unyielding to meet any pressure from the sutures when tightened. Besides the advantages of other bobbins, it is claimed that this one cannot slip away, and that when the sutures are tied the parts resected are brought together without excessive pressure on the edges of the bobbin. A purse-string stitch (Fig. 125) is run round each end of the gut; then

FIG. 128.



For side to side union.
Allingham's bobbin.

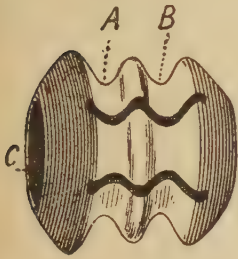
For end to end union.
Stanmore Bishop's bobbins.

one end of the bobbin is inserted into one segment of the intestine, and the suture is pulled tight by a knot twice threaded (Fig. 126), which will not slip, but the final tie is not made until the other end of the bobbin has been inserted into the other segment of intestine. After this each suture is tightened to its utmost, the ends of the intestine being thus drawn down to the centre of the bobbin (Fig. 127), which from its shape ensures that the tighter the sutures are drawn, the more securely must the intestine ends be drawn to meet in the centre of the bobbin.

A few Lembert's sutures or a continuous Lembert's suture may be used if thought desirable. It is well to lightly scarify the serous coat for half an inch round the union to promote exudation of lymph. This button has been successfully used on the human subject by Mr. Allingham.

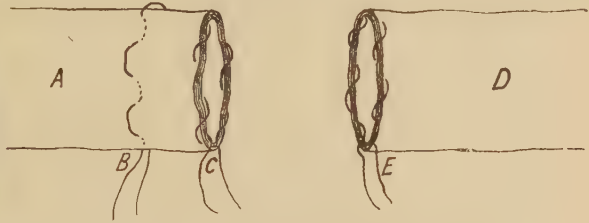
Mr. Stanmore Bishop's button (*Lancet*, vol. ii. 1902, p. 505) has all the advantages of that of Allingham, and is much more easily introduced

FIG. 129.



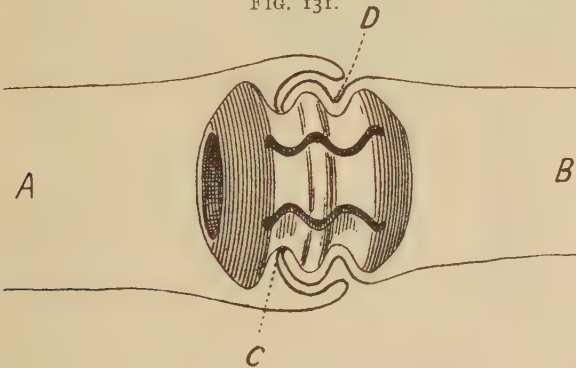
A B, Central part not decalcified, partly segmented by saw-cut. C, Lumen in decalcified end.

FIG. 130.



A D, Proximal and distal intestine. C E, Purse-string sutures. B, Sub-serous purse-string suture, by which, after union of the intestine, one part is invaginated over the other.

FIG. 131.



C, Proximal groove in which the two marginal sutures secure the orifices of the two parts of the intestine, A and B. D, Distal groove where sub-serous purse-string presses the proximal intestine over the invaginated distal part.

End to end union by Hayes' bobbin.

on account of its conical ends, and it facilitates suturing to a greater degree.

Hayes' Bobbin (Figs. 129 to 131).—Mr. Hayes has devised (*Lancet*, vol. i. 1895, p. 1619) another ingenious button, partly decalcified, by which he obtains additional security by easily invaginating one piece of resected intestine within the other. It is not stated whether the bobbin has been successfully used on the living subject. The drawings are so clear that they explain this method of themselves.

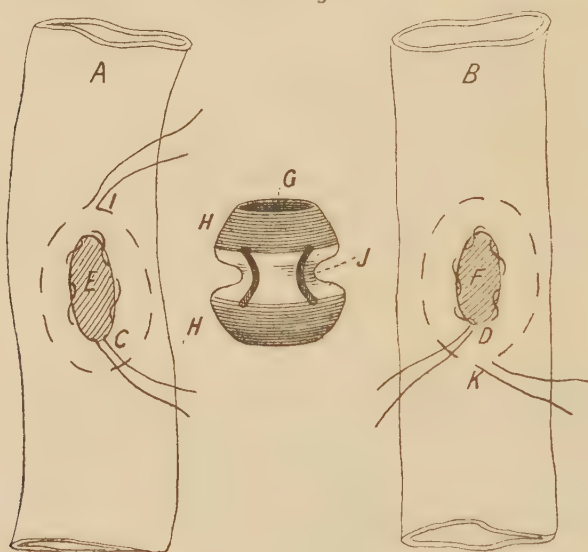
Numerous varieties and modifications of bobbins have been introduced, notably by Paul, Bailey, Jesset, McLennan, and others; but

most of them are difficult to prepare and procure, and but few of them are capable of easy and rapid application. There is nothing to be gained therefore by describing any more of them here, however ingenious some of them may be.

Paterson (*Lancet*, 1905, vol. i. p. 858) has described a soluble button made of gelatin hardened in a solution of chrome alum; it consists of a male and female part, like Murphy's button, and is introduced in a similar manner. It is not stated that it has been used in the human subject yet.

Simple suture is more generally applicable than any button or bobbin, and it should be the surgeon's aim and duty to perfect himself in this

FIG. 132.



Lateral anastomosis by Hayes' bobbin. E and F, Apertures to receive the bobbin. D and C, Marginal sutures. K and I, Sub-serous purse-string sutures.

method, which makes him independent of foreign bodies, that are not always suitable or available.

O'Hara's Forceps (*Ann. of Surg.*, 1901, vol. xxxiii. p. 179).—The following description of this instrument is given in Dr. O'Hara's own words:—

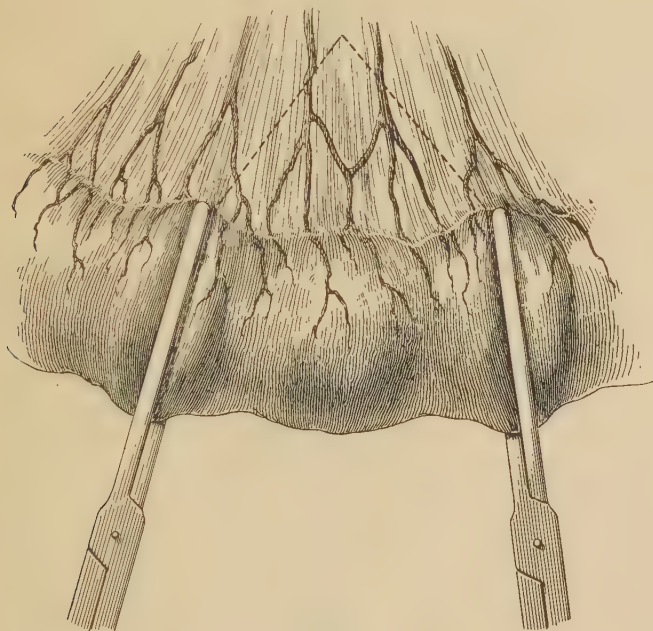
"The instrument consists of two pairs of straight forceps, the jaws of which are very slender and two and a half inches long for ordinary work; for special work they can be made longer. Instead of being roughened, as in the ordinary hæmostatic forceps, they are grooved down the centre of one blade; the opposite one has a ridge similar to a pile clamp: both forceps are held together by means of an adaptation of the serre-fine."

The serre-fine having been removed, the forceps are applied and locked with their extremities just on the mesenteric border, as shown in the figure. The intestine is divided quite close to the forceps,

the portion removed being clamped at both ends to prevent any leakage (*vide* Figs. 133 and 134).

The two forceps are brought and fixed together by means of the serre-fine clamp, and Halsted sero-muscular sutures are then inserted, starting from the free border of the bowel. At the mesenteric border some care is necessary to produce sufficient inversion, and it may be necessary to nick the mesentery and push it back a little, so that the bowel can turn in more easily. The forceps are then turned over, and sutures are passed and tied as shown in the figure. The forceps are unclamped, and one pair is unlocked and removed by traction; the

FIG. 133.



Showing the manner of placing O'Hara's forceps in resection of the intestine. Note that the ends are on the mesenteric border. The forceps should be placed more obliquely, so that more of the free border of the bowel can be excised. (After O'Hara, *Ann. of Surg.*)

other is unlocked, and also passed up and down within the intestinal canal to make sure that none of the sutures have included both walls. The forceps are then withdrawn, and the opening is closed by one stitch. A continuous Lembert suture may be used either instead of the Halsted stitch or to reinforce it.

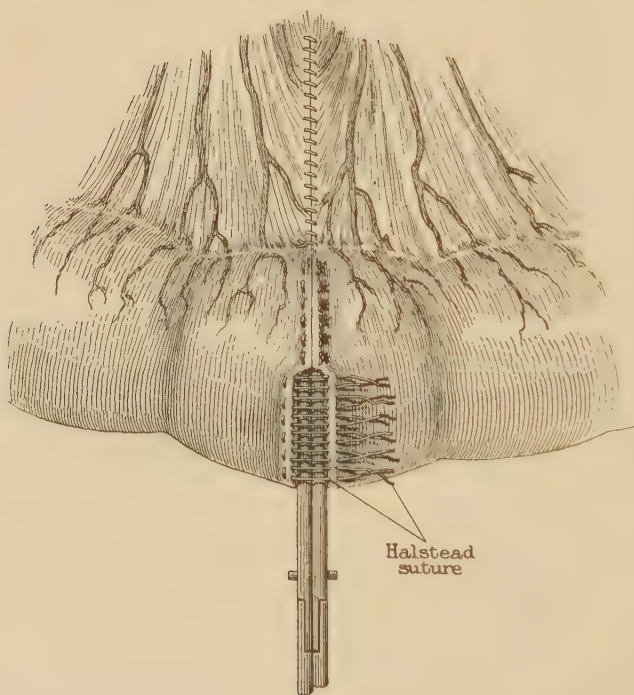
The advantages claimed for this method are (a) that the union can be made very rapidly, although not so speedily as with a Murphy's button; (b) that the danger of sepsis from soiling with fæces is unusually slight, because the bowel cavity is closed off at the very beginning of this operation; (c) accuracy of apposition; it may be objected that the inverted ends are not joined at their edges, so that fæces may soak outwards towards and infect the sutures; (d) simplicity:

in this it compares very favourably with the anastomosis by means of the Laplace's forceps, which are rarely used now (*Ann. of Surg.*, March, 1899); (e) wide range of application to the intestines, stomach, and gall-bladder.

The chief objections to the method are—

(a) A diaphragm has been known to form owing to the large amount of inversion that may be produced. F. T. Stewart (*Ann. of Surg.*, 1903, vol. xxxviii. p. 135) records a fatality from this cause. The forceps had been used after the excision of gangrenous intestine. A secondary

FIG. 134.



Forceps brought together and locked, mattress sero-muscular stitches inserted; some of them have been tied. (After O'Hara, *Ann. of Surg.*)

resection became necessary owing to the obstruction by means of the diaphragm.

(b) The sutures, which do not pierce the whole thickness of the bowel, may yield and lead to leakage about the fourth day; but it is only fair to say that this is not so likely to occur when a Halsted's stitch is employed as when other forms of sero-muscular suture are used.

(c) The pressure of the forceps may damage the bowel and lead to infective necrosis of uncertain limit.

Comparison of Enterorrhaphy with the Chief Devices intended to Aid or Replace it.—Enterorrhaphy by circular suturing must be admitted to be the ideal operation from its simplicity, the entire absence of any especial apparatus, and the fact that no foreign

body is left behind which may perhaps give trouble ere it come away. Those who condemn it as unsuccessful must remember (1) that it has been gradually and slowly perfected, being often laid aside for some new device and then resorted to again, and that it was very largely used in the earlier and darker days of intestinal surgery; (2) that when used by skilled hands it has proved most effective and reliable in the time of emergency.* When used by such hands—and it is one advantage of this method that it is easy for any operating surgeon to acquire skill in it—care will be taken to fulfil the conditions necessary for successful enterorrhaphy, viz., (a) sufficient inversion of the serous coats; (b) penetration of all the coats by one of the rows of stitches, which should have all knots on the mucous surface; (c) careful adjustment of the junction of the intestine and the mesentery (Figs. 103, 104, 142); and (d) placing of the sutures in healthy tissues.

It is right to state clearly here that many excellent judges, men well experienced in intestinal surgery, condemn circular enterorrhaphy. Thus Dr. A. B. Robinson (*Ann. of Surg.*, vol. i. 1891, p. 430) states that he found it, from experiments on dogs, very dangerous, for the following reasons: (1) It paralyses the gut, and hence does not so readily relieve the fæcal obstruction which is the immediate object of surgical interference. To this it may be replied that, as shown at p. 385, the joining of ends of intestine resected while obstruction is present should be deferred whenever possible; and when this is not possible—a rare contingency—the intestines should be thoroughly emptied before they are resected. If this is not practicable, union should be deferred and drainage continued by Paul's tubes (Fig. 97, &c.). (2) A fæcal fistula is apt to arise at the point of suture. (3) Gangrene or sloughing may arise from the pressure of numerous sutures. These are very fair criticisms. They must each be met by care in suturing, and by attention to the junction of the intestine and the mesentery. (4) The lumen of the two ends may be unequal. When this difficulty is marked, circular enterorrhaphy must be abandoned for intestinal anastomosis. (5) Pathological changes due to obstruction in the bowel may offer impediments. The gut may be stretched so thin that a needle cannot be passed between the muscular and mucous layers without danger of penetrating the mucous layer and causing fæcal fistula, but with Connell's suture this does not matter so much. I have pointed out elsewhere (p. 385) that union of resected intestine is not to be attempted where obstruction, over-distension, &c., are present. Where the distension has been prolonged, as in malignant disease low down in the canal, circular enterorrhaphy is contra-indicated. This is not the case where the obstruction has been of shorter duration—*e.g.*, in gangrenous herniæ—as shown by the successful cases given at p. 393. (6) Circular stricture followed the experiments. Some of the strictures were so severe that both fæces and gases were actually obstructed. This is a very rare sequel in the human subject, as shown lately by W. A. Evans. (7) The long time

* To mention a few cases only, I refer my reader to those of Mr. Lockwood and to Dr. McCosh's four successful cases of circular enterorrhaphy after resection of small intestine for gangrene. To such urgent emergencies, circular enterorrhaphy is especially suited if the surgeon has had sufficient practice to rely on himself.

required for a circular enterorrhaphy militates against the chances of recovery. Of all surgery in the world, intestinal surgery should be rapid and skilful. Of the different methods, Dr. Robinson recommends Lembert's sutures, making these continuous for two, three, or four stitches. This worked well and saved time, three to five interruptions of Lembert's sutures completing the circle round the gut. In this way a circular enterorrhaphy can be completed in less than half an hour. At the present day end to end union with continuous suture can be performed in less than half this time. Dr. Robinson emphatically opposes a circular enterorrhaphy with a continuous Lembert's suture. "This was carefully tried, and the worst strictures of all resulted; not only that, but the thread gradually fell into the gut lumen, and its end dangled for days and even weeks there before it became entirely set free. This long thread will certainly be a dangerous source of infection, as infective fluids can go along it by mere capillary attraction, not to speak of the wider fæcal fistula it may create." There is much weight in these last two criticisms. An increasing number of recent successful cases of circular enterorrhaphy, amongst these being one by Lockwood (p. 393), three by McCosh (p. 393), one by Ransohoff (p. 393), and many by Continental surgeons, show, however, that they are not unanswerable.

Dr. Frank, writing in 1902 (*Ann. of Surg.*, vol. xxxv. p. 36), advocates the use of mechanical means, such as the Murphy button and the Frank coupler, believing that these methods are much safer than direct suture. This does not agree with general American opinion, however.

Messrs. Ballance and Edmunds (*Trans. Med.-Chir. Soc.*, 1896) have carried out an experimental inquiry with especial reference to the question of the best means of uniting resected intestine. The following, very briefly put, are some of the conclusions to which the authors were led with regard to enterorrhaphy, and other methods of resecting intestine. With regard to end to end union, the above-mentioned authors prefer simple suturing to the use of any form of supporting apparatus. They recommend either the Czerny-Lembert or Maunsell's method. Of five experiments on dogs performed by the former and two by the latter method, all did well. With regard to the Czerny-Lembert method, emphasis is laid on the care needed at the mesenteric junction and on the following facts. In the small intestine eversion of the mucous membrane takes place to such a marked degree that the insertion of the inner row of sutures only results in apposition of mucous membrane to mucous membrane. Thus the integrity of the junction depends solely on the Lembert sutures. The result of the inversion produced by these is a ridge which remains at the line of junction, sometimes seriously contracting the lumen of the gut. This untoward result is especially likely to be brought about if the surgeon is uncertain about the efficiency of his row of Lembert's sutures, and is tempted to put in others, still further diminishing the lumen of the bowel. The above objection does not apply to Maunsell's method, which produces very perfect union, mucous coat being united to mucous, muscular to muscular, and serous to serous. After the Czerny-Lembert method a circular ridge or diaphragm is always to be found on laying open the intestine. This is not so after the Maunsell method: here it is quite difficult to recognise the line of circular

junction, this presenting a marked contrast with the ridge seen at the site of the longitudinal incision which had been closed by Lembert's sutures.

Of the different methods of producing **lateral anastomosis**, Mr. Ballance and Mr. Edmunds consider Halsted's (Figs. 155 to 157) to be superior to all in which plates, bobbins, and other mechanical aids are used. The above-mentioned authorities emphasise one objection which applies to all of the above—viz., that the surgeon may very likely, in cases of emergency, not be provided with the size he requires. As to the claim that such devices shorten the time of operation, Messrs. Ballance and Edmunds reply: (1) That if, as in Senn's method of anastomosis, sutures have to be placed around the plates, the time taken is not much shortened. (2) Such a method as Halsted's lateral anastomosis does not take long if proper attention is paid to the following essentials: (a) A plentiful supply of round needles ready threaded with silk sufficiently thick not to cut the intestinal coats. (b) Using the needles as splints. Thus, if, just as one thread is coming to an end, the needle which carries it be left *in situ* transfixing the cut edges, this will keep the parts together and greatly facilitate the introduction of the next suture.

It is becoming increasingly clear, I think, that, in the hands of an operating surgeon who has taken care to acquire skill by practice, the chief **objections** to enterorrhaphy will be very greatly reduced—viz., the time taken, the number of sutures needed, the risk of yielding of sutures, of leakage at the junction of mesentery and intestine, and of stenosis from contraction of the cicatrix, especially if the inversion has been needlessly free.

Where the surgeon, from any want of faith in his skill, or from the condition of the patient requiring that the operation should be completed speedily, prefers to rely upon one of the devices intended to aid or to replace circular enterorrhaphy, he will be wisest in making use of Murphy's button, or Mayo Robson's bobbin, or Stanmore Bishop's modification, which I consider to be a distinct improvement. Of these Murphy's button is highly to be recommended on account of the rapidity with which the operation can be completed. For although there are undoubted objections to the use of the button, as above described, careful adjustment in well-nourished intestine, and a wise selection in choosing the size of button to be used, will avoid most of them. Moreover, it must be remembered that the accidents that have happened are comparatively rare, and the results, as far as can be judged, are on the whole satisfactory. Comparison between Murphy's button and other methods of resection in the series of 226 cases of resection of intestine for gangrenous hernia collected by Gibson (*Ann. of Surg.*, November, 1900) is on the whole to the advantage of the Murphy button, for in the 63 cases in which Murphy's button was used there were 14 deaths, *i.e.*, a mortality of 22 per cent., while in the remaining 163 cases in which various other methods were made use of there were 44 deaths, or a mortality of 27 per cent.

Ferguson (*Ann. of Surg.*, 1901, vol. xxxiv.) states that in 115 anastomoses by means of the button, and performed by graduated students, on dogs the mortality was only 2 per cent., whereas in 300 operations by Connell's method the mortality was 3 per cent. In 50 operations

by the Czerny-Lembert method the mortality reached 22 per cent., and in 50 operations after Maunsell's manner 25 per cent. of the dogs died.

Moreover, Sir F. Treves (*Brit. Med. Journ.*, Aug. 28, 1898) considers that the Murphy button is the best means of uniting divided intestine, having employed it in 50 cases with satisfactory results.

Mayo Robson's bobbin, by giving support, facilitates the suturing at the time and supplies some of the conditions which are at the root of Senn's excellent principle—viz., the giving support to the ends of the intestine by a body which will be safely absorbed—while its ready applicability to a very large range of different operations puts it, in my opinion, on an equal footing with Murphy's button. Moreover, the part it is intended to play, and the material of which it is made, render it far safer than that most ingenious device.

The same absence of any threads to tie, and its wider applicability, make Mr. Robson's bobbin superior to Mr. Paul's decalcified bone tube, though several successful cases prove the efficiency of this device.

The choice may be said, therefore, to lie between direct suture, Murphy's button, and decalcified bone bobbin. For the great majority of cases I prefer to use deep and superficial sutures, or Connell's suture. Which of these methods will be finally judged to be the best is still uncertain.

RESECTION OF INTESTINE. ENTERECTOMY. COLECTOMY.

Indications for Resection Operations.—The chief of these are: (1) New growths.* (2) Gangrene after strangulation in hernia or intestinal obstruction. (3) Injuries, gunshot or otherwise. (4) Some cases of irreducible intussusception. (5) Some cases of artificial anus where the canal of the intestine cannot be otherwise restored.

I propose to say a few words about the first two, the most frequent of the above indications.

The subject of resection for gunshot and other injuries is fully dealt with in the next chapter.

(i.) **Indications for Resection in New Growths.**—In deciding between resection and one of the forms of anastomosis without resection, or between resection and artificial anus, the surgeon should pay particular attention to the following points, both local and general. The more they are present, the more favourable is the case. Small size, definite outline, especially if the growth approaches the annular form, free mobility as pointing to absence of adhesions, entire absence of that tenderness which points to peritonitis, or even to that breaking down and suppuration which may accompany new growths when they ulcerate and become septic, a situation in which the growth can be easily got at and isolated, *e.g.*, when it attacks a portion of intestine

* These are nearly always carcinomatous, but Corner and Fairbank have related a fatal case of a secondary resection of a sarcoma of the colon, which had produced intussusception, in a boy of nine years of age. The growth was first noticed during the reduction of the intussusception about two months earlier. Only 11 cases of sarcoma of the colon are recorded (*Pract.*, June, 1902).

with a long mesentery, and not a fixed part such as the splenic or hepatic flexure.* These are the chief local points. Most of these patients die from the local effects of their growth and not from dissemination, therefore it is very important to diagnose and operate for this condition while the growth is still removable, and especially before the intestines become distended and damaged from increasing obstruction. When a patient approaching or past middle age complains of constipation, perhaps alternating with occasional attacks of diarrhoea, flatulent dyspepsia, griping pains, wasting and anæmia, a growth of the colon should be suspected, and the whole course of this bowel examined carefully. In this way a growth may often be discovered before distension develops. Rectal and bimanual examinations of the pelvis and of both loins may enable the surgeon to feel a tumour. Visible peristalsis is a very valuable sign, and gurgling at one spot may sometimes terminate a griping attack, and indicate the probable site of the disease. The passing of blood and slime generally indicates that the growth is below the transverse colon.

Vomiting may not occur until quite late, and may then herald the approach of the complete obstruction that is too often allowed to occur. In cases of doubt or of strong suspicion, an early exploration is strongly advised, for with early removal of the growth the prognosis is good.

Amongst the general points that must weigh with the operator are the strength and nutrition of the patients, their fitness to bear a severe operation and to supply the needful plastic repair.

Another point having a most important bearing upon the advisability of performing resection for malignant disease is whether this is complicated by obstruction, tympanites, &c. If there is one point which published (and still more the unpublished†) cases prove, it is that the occasion in which it is right to submit a patient the subject of intestinal obstruction to such a prolonged operation as resection and suture or anastomosis of the resected parts must be of the very rarest.‡ This is plain from the usual state of the patient in these cases, and the conditions within the abdomen with which the operator has to deal. Is a patient, usually past middle life, whose strength and powers have been sapped for days or weeks by the nausea, inability to take food, vomiting, distension, and all the distress which forms part of a *miserere* of the later stages of chronic intestinal obstruction, in a fit state to go through

* In the tables of Weir (*New York Med. Journ.*, Feb. 13, 1886; Butlin, *Oper. Surg. of Malig. Dis.*, p. 231), of the 37 cases collected in which resection of cancerous bowel was performed, 32 were of the large intestine. The parts involved were—cæcum, 7; ascending colon, 4; transverse colon, 3; descending colon, 7; sigmoid flexure, 9; "colon," 2. Malignant disease is so frequent in two regions, the ileo-cæcal and the left iliac fossa, that when there is any reason to suspect it an early exploratory incision should always be made.

† Quite as instructive in their way. "Nec silet mors."

‡ Dr. Ricketts (*Ann. of Surg.*, vol. i. 1894, p. 472) relates a case which was most favourable for resection. The growth, only of the size of a hickory nut, was easily found, drawn out, and resected. The ends were united by a Murphy's button. The ileum being enormously distended with faecal fluid, owing to the patient having deferred operation till the last, about a gallon was withdrawn by an incision, which was closed by Lembert's suture. The patient sank ten hours later.

a prolonged operation, and to supply after it the plastic repair which is needful for success? There can be but one answer here. And it is the same when we examine those local conditions which will have to be faced by the operator. The distension of the intestines, and the difficulty of keeping them within the belly, prolong the operation, add to the shock in an exhausted patient, and, by rendering asepsis most difficult, diminish his chances still further. Another point, viz., the condition of the intestine above and below the obstruction, is a strong argument against resection and union of the intestine when obstruction is present. Above, the intestine will be distended, congested, softened, and septic; below, empty and shrunken. The difference in the size of the two sections may prove a serious difficulty in their union, but a graver objection to uniting them now is the fact that for the present both are paralysed; and though this can be met, in a measure, by emptying the contents of the upper bowel when this is cut through above the growth, yet everyone familiar with these cases knows perfectly well that if the obstruction be low down it is extremely difficult to empty the bowel above sufficiently in the short time available. Much of its contents are left behind; the condition of obstruction largely continues, with its result—a continuance of toxic absorption; and if the contents of the intestine are passed on from above, too often they find the junction of the resected parts, made in softened, inflamed tissues, unfit to bear the strain. Where obstruction is present, resection should be deferred until one of the following steps has been adopted. Colotomy may be performed in the cæcum or some part of the colon, to empty the intestine and restore its tone, while at the same time the patient's strength is restored, and the surgeon chooses his own time for the performance of what is a very severe operation. Dr. Elliot (*Ann. of Surg.*, 1905, vol. xlii. p. 688) states that the mortality of primary resection and immediate suture in these cases is at least 50 per cent. even in the hands of the best surgeons, and in some hospitals it is as high as 85 per cent. Peritonitis is the chief cause of death, and this is nearly always due to the fact that the most perfectly placed sutures or mechanical devices do not hold. Another cause of death is shock partly due to an unnecessarily long operation. Dr. Bell Walker analysed the records of enterectomies performed at Guy's Hospital from 1900—1905 and found that only two recoveries had followed resection and immediate enterorrhaphy undertaken during actual intestinal obstruction; and in neither of these patients was the obstruction due to growth. Another way of performing resection in two stages is that advocated by Mr. F. T. Paul,* whose name will frequently occur in these pages, as an authority in abdominal surgery. The following are the chief steps of this operation. 1. Explore first in the middle line unless the site of the obstruction is known. 2. Make a sufficiently free incision over the site of the obstruction. 3. Having cleared away any adhesions, tie the mesentery, and divide it sufficiently to free the bowel well beyond the growth on each side. 4. Let the loop of bowel containing the growth or stricture hang out of the abdomen, and sew together the

* "Colectomy" (*Brit. Med. Journ.*, vol. i, 1895, p. 1136). A paper full of practical information, but especially noteworthy and admirable, nowadays, from its convincing candour. Failures are related as well as successes, and are equally instructive.

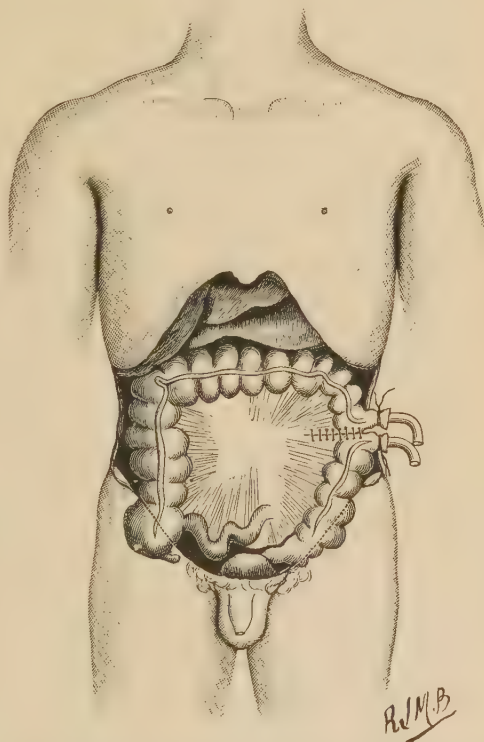
mesentery and the adjacent sides of the two ends (Fig. 135). See that the stump of mesentery lies beneath the bowel, where, if deemed advisable, it can be drained by packing cyanide gauze down to it. 5. Ligature lightly a glass intestinal drainage-tube (Figs. 97 and 135) into the bowel above and below the obstruction, and then cut away the affected part. When the operation is thus performed, all the vessels except those in the primary incision are tied before they are cut, and the intra-peritoneal work is rendered bloodless. Elliot (*loc. supra cit.*), writing in 1905, describes and recommends a very similar

method to the one described by Paul ten years earlier; in some respects, Elliot's method is an improvement, thus an attempt is made "to close the wound about the ends of the intestine as much as possible" before the upper distended bowel is clamped and the tumour is removed. The lower end of the loop below the obstruction is divided between clamps at an earlier stage to facilitate the suturing of the mesentery, and of the two limbs of the loop together. "The important point is not to open the upper distended bowel until the peritoneal cavity is closed." No tube is used, but the clamp forceps may be left on for a few hours unless the symptoms are urgent. This plan is not so good as that of Paul in this respect.

6. The second stage of the operation—that of destroying the spur which, as will be gathered from Fig. 135,

is formed by the above operation—is undertaken about three weeks later. A finger being introduced into the bowel, as a guide to each side of the spur, dressing-forceps with the handles fastened together by india-rubber tubing are applied to the spur, one blade on each side. Paul's enterotome, which can be gradually tightened by means of a screw, is to be preferred if available. These will come away within a week, and some days later the rest of the spur is destroyed in like fashion, the forceps being now applied as far as the finger makes out the spur to reach. As soon as this is satisfactorily accomplished the artificial anus is closed by separating the rosette of mucous membrane from the skin, turning it in, and bringing the freshened edge of the latter over it.

FIG. 135.



Colectomy by Paul's method. Drainage of the bowel, and preparation of it for subsequent safe resection of the bowel. (Paul.)

Another method is to get the affected coil outside; if this be not too tied down by adhesions, keep it out by means of a rod passed beneath it, a Paul's tube being then tied into the upper end to drain it. Some days later, when the patient's condition admits of it, the growth is resected, and the two ends united. Mr. Lane adopted this plan successfully in a very interesting case of growth of the lower part of the ileum. A knitting-needle covered with india-rubber tubing was employed here to keep the bowel outside (*Clin. Soc. Trans.*, vol xxvi. p. 40).

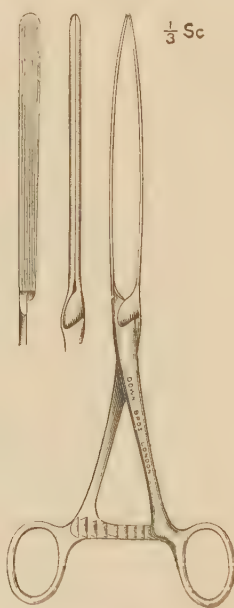
Hochenegg leaves the loop outside the abdomen for about twelve days and then resects it; there is no advantage in waiting so long.

FIG. 136.



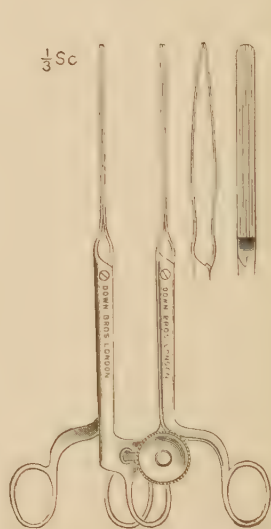
Mr. Watson
Cheyne's fine
dissector.
(Down's Cata-
logue, 1894.)

FIG. 137.



Doyen's clamps.

FIG. 138.



Carwardine's clamp forceps. The
two pairs lock, and hold the two
ends of intestine close together for
suturing. (Down's Catalogue.)

Littlewood successfully employed this method in two cases, and removed the growth without an anæsthetic (*loc. infra cit.*).

The chief disadvantages of the method are the following:—

(a) The prolapsed loop containing the growth is apt to become very congested and swollen, and (b) unless the mesenteric glands have already been removed they may become infected; (c) the difficulty in these cases is to get the loop outside, and to allow this some of the mesentery may need ligaturing and severing; once the growth is delivered, its removal, conducted outside the abdomen, does not materially increase the time of the operation and the degree of shock. For these reasons I prefer to remove the growth at once, with proper precautions to prevent soiling of the peritonæum, and with provision for immediate drainage by means of enterostomy tubes.

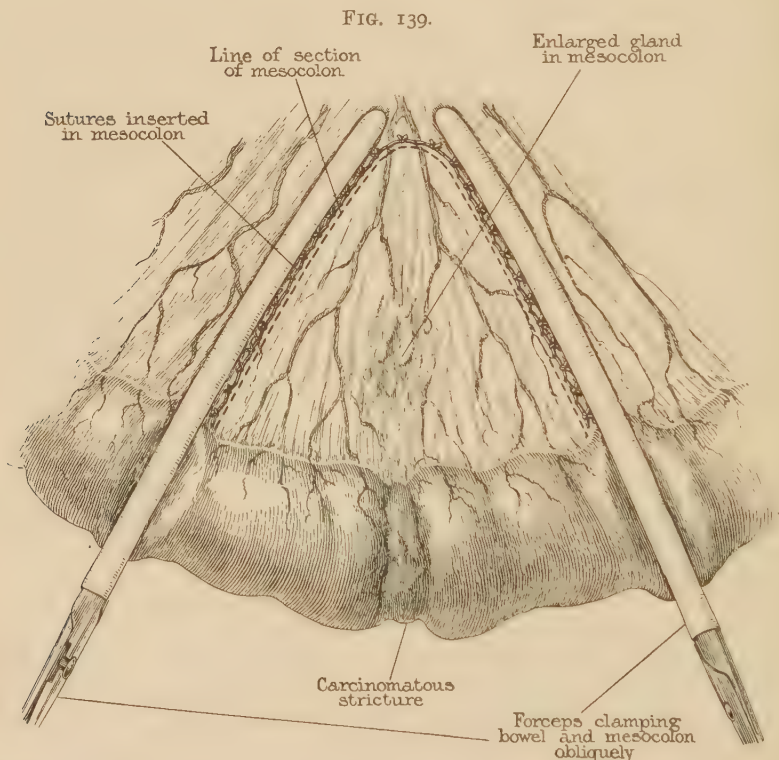
Operation.—The first question which arises is as to the best incision. If the surgeon is uncertain as to the exact site of the growth, he may

make a median incision and clear the matter up; otherwise the incision should be made over the growth itself, either obliquely, as in an incision for appendicitis or for left-sided inguinal colotomy, or vertically, or in one *linea semilunaris*. The variety of the incision is immaterial as long as the growth and the intestine entering and leaving it is thoroughly exposed. That the median incision is not best suited for this is shown by the number of cases recorded in which, after the operator had begun by an incision in the *linea alba*, he abandoned it, as inadequate, for one over the growth. The growth, when reached, may be covered by adherent omentum, or resemble an intussusception, appearing as a thick rounded, firm, sausage-like swelling. When the growth is fully exposed the surgeon settles whether to attempt resection or to perform a lateral anastomosis (p. 402). Resection being decided upon, the field of operation is carefully shut off from the general peritonæal sac by sterile gauze. The amount of bowel to be resected will depend chiefly upon three things (*a*) the size of the growth: at least one and a half inches of apparently healthy bowel at each end should be removed with the growth to make certain of cutting through healthy tissues. (*b*) The position and degree of fixation of the growth: for instance, the splenic flexure is so fixed that it cannot be brought down and joined to the lower end after excision of the descending colon, therefore it is wise to excise it and to use the more movable transverse colon (Pollard, *loc. infra cit.*). Again the cæcum may have to be removed for the same and other reasons, as in my case quoted below. The ends must meet without tension. (*c*) Due consideration should also be given to the blood supply. I shall first describe a comparatively simple case—*e.g.*, resection of a limited growth of the small intestine or sigmoid, and, later, the more difficult removal of the ileo-cæcal coil. Any adhesions present must next be divided with a blunt-pointed scissors or a dissecting tool (Fig. 136). Any bleeding vessels should be clamped and tied at once, or tied before they are divided if possible. The difficulty met with here varies extremely. The adhesions may be so dense as to render further operation impossible. In such a case short-circuiting should be performed. Omental adhesions are not uncommon—*i.e.*, to the parietes, over the growth or adhesions between the omentum, and the small and large intestine contiguous to the growth. The loop having been freed is brought outside the wound, placed upon gauze, and emptied by gentle pressure with the fingers in both directions. This effected, clamps are applied well above and below the spots where it is decided to divide the intestine. A host of such instruments have been devised. The best are those of Doyen and Carwardine. These will be found extremely useful on account of the handles, by means of which the steps of the operation are greatly facilitated. Carwardine's clamps can be locked so as to automatically hold the ends together during the insertion of sutures (Fig. 138).

Several other clamps act by perforation of the mesentery. A very simple method is that of Neuber, in which a narrow elastic band or rubber tubing is passed through a small opening made in the mesentery, close to the intestine, and tied or clamped around the gut. Others have used cords of gauze. Fig. 140 shows a clamp devised on the same principle by Mr. W. A. Lane. In using any clamp which

perforates the mesentery, great care must be taken not to injure any vessel. This is easily managed in the case of undistended intestine, but when obstruction is present and all the small vessels enlarged, very troublesome bleeding may follow perforation of the mesentery.

Whatever form of clamp is used, if it has been long *in situ* or applied too tightly it may be well to shift it, and to cut away the ends of the intestine which have been submitted to pressure, for fear that their nutrition has suffered dangerously.



Resection of the intestine for growth. Note that the sheathed clamps are placed obliquely, and that the mesentery is tied before it is divided. Shorter and unsheathed clamps are also applied between those shown in the figure and the growth to prevent any leakage from this part.

Where no clamps are obtainable an assistant's hands must be made use of. But handled clamps are much to be preferred; hands are more in the way, and, however willing, are liable to make more varying pressure, and to relax long before a tedious operation is completed.

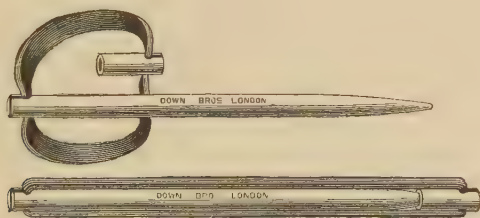
If the intestine is at all distended,* it is emptied in the manner advised at footnote, p. 397. The diseased mass is now isolated by two more clamps placed between the first two and the growth, which is

* After emptying the intestine there may still remain much difference between the ends when resected. Both ends must then be closed and inverted, and a lateral anastomosis made.

resected with blunt-pointed scissors, the gut being cut across nearly at right angles to its long axis an inch and a half beyond the growth. More of the bowel is removed at the free than at the mesenteric border, so that the ends that remain may be well-nourished. This should leave about half an inch of gut beyond each sheathed clamp, in order to allow of easy introduction of the first row of sutures. About two inches should be left projecting if a Murphy's button or a bobbin is to be used. The ends are carefully cleansed. In the present instance, resection of intestine for growth, the incisions should be carried onwards through the mesentery so as to remove a triangular piece with the base below at the intestine. By this means it is probable that any implicated lymphatics will be removed as well. The cut vessels in the mesentery are either clamped and tied with catgut, or, where a large piece has to be removed, they can be secured before, and hæmorrhage avoided, by means of an aneurysm-needle carrying catgut (Fig. 139).

The soiled gauze which has shut off the field of operation is next replaced by fresh, and the surgeon decides whether to unite the

FIG. 140.



Lane's intestinal clamp. (Down's Catalogue, 1894.)

intestine end to end by direct suture, by Murphy's button, or Robson's bobbin, or to perform lateral anastomosis of the two parts, which may be of unequal size.

With regard to the details of the steps adopted in the more difficult operation of resection of the ileo-cæcal coil, I shall quote from a very helpful report of a case by Mr. Lowson, of Hull (*Lancet*, vol. i. 1893, p. 618) :

The abdomen having been opened by an incision in the right linea semilunaris, the omentum was found adherent to the tumour anteriorly, and detached after ligature. "Pushing the colon inwards," I now entered the scissors above the level of the tumour, through the peritonæum lining the posterior wall of the abdomen, to the outer side of the great bowel, and ran it down to a point opposite the lower end of the cæcum. The bowel could now be easily separated from its bed. It still remained to divide the peritonæum on the inner side where the colic vessels spread out, fan-like, to supply the colon. This was done by tying the serous membrane with the vessels in five or six successive pieces, and dividing between the ligatures and colon. The line of this incision inclined downwards and inwards, meeting the ileum as it crossed to join the colon five or six inches from the ileo-cæcal valve. Several diseased glands were included in this triangle. The ileum was separated from the mesentery in the same way, and now the greater part of the ascending colon, with the cæcum and four or five inches of the ileum, were free along with the tumour. The time had now arrived for dividing the bowel. Two long Makins's clamps were applied to the colon above the tumour, and between these the bowel was divided as nearly at right angles as possible. The ileum having been divided, and the diseased portions removed, the ends of the

intestine were closed by fine continuous sutures and turned in by Lembert's sutures. Lateral anastomosis was performed by means of Senn's plates. Mr. Lowson draws attention to one detail, which, as he says, "cannot be neglected without fatal extravasation—i.e., to be especially particular to bring the serous surfaces accurately in apposition at the point where the mesentery joins the intestine, and where the serous coat of the mesentery is deficient behind." The patient, aged 33, made a good recovery, and thirteen months later there was no perceptible recurrence.

In a recent case of carcinoma of the ascending colon and hepatic flexure, one of us (R. P. R.) found considerable difficulty in bringing the growth out of the wound, but this was accomplished in the manner described above by Mr. Lowson. Bleeding was difficult to stop in the depth of the wound near the head of the pancreas, to which and to the duodenum the growth was slightly adherent, and the ureter was exposed and avoided. It was found to be impossible to sever the colon well away from the growth and yet to leave enough of the ascending colon to join to the transverse colon, without trespassing upon the region of the ileo-cæcal valve. The cæcum and about two inches of the ileum were therefore removed with the growth, and an end to end union made between the ileum and the transverse colon, by means of two layers of sutures, and this was easily accomplished because the two ends were of equal calibre. This plan was preferred to lateral anastomosis also for another reason, *e.g.*, it could be carried out more speedily, as some valuable time would be consumed in closing the separate ends. The man recovered, but a fæcal fistula formed and had to be closed later.

In a case of excision of the cæcum and part of the ileum for multiple fistulæ due to tuberculous disease, I used a Murphy button, because of the impossibility of bringing a very adherent ascending colon into the wound, and the child was already collapsed. She recovered without a fistula and gained weight very rapidly, being stout and well when I last saw her two years after the operation.

Mr. Bilton Pollard (*Lancet*, 1904, vol. i. p. 175) records seven cases of excision of carcinomatous growth of the colon; all these patients survived the operations, and one was alive and well four years afterwards, another after two and a half, and a third after two years and two months. One died of heart disease after four years. The others were recent cases operated upon nine, six, and two months before publication. End to end union was made by direct suture, two rows of stitches being used. The parietal wound was drained in only one case—one in which a portion of the kidney was excised due to invasion of growth. Mr. Pollard's patients were well a year after his paper was written, and he had performed two more colectomies successfully during the year.

Mr. Littlewood (*Lancet*, May 30th, 1903) publishes 14 cases of resection of the colon for columnar-celled carcinoma with 10 recoveries. End to end union was made by means of Czerny-Lembert sutures of catgut in all except one, which in lateral anastomosis was used instead, because the ends could not be brought together, the ileum was joined to the sigmoid colon; death occurred six days later. "Of the six successful cases of primary colectomy, there was practically no obstruction at the time of the operation." In one case there was obstruction, but the condition of the intestine seemed to be so good that an immediate resection was undertaken, but the stitches tore out and death occurred from peritonitis on the sixth day. This case illustrates the danger of primary resection and suture in cases of obstruction.

Mr. Mayo Robson (*Lancet*, 1904, vol. i. p. 1553) states that he has performed twenty-one enterectomies for growth in private practice with four deaths; one patient was well ten years after the operation, one after four and a half years, three after three and a half years, two, three years,

and one, one year, without a sign of recurrence. In 31 hospital cases the primary mortality was 18 per cent.

Mr. Robson states that Professor Morton, employing the decalcified bone bobbin, has performed seven consecutive colectomies, without a death. Homer Gage (*Bost. Med. Surg. Journ.*, Sept. 10, 1903) in a collection of 56 cases by famous operators found that 13, or 23 per cent., had survived the three year limit without any sign of recurrence. These results are very good and they serve to indicate that early resection of carcinoma of the colon is attended with considerable success. The figures are too favourable, however, for unsuccessful results are not published nearly often enough.

(ii.) **Resection of Intestine for Gangrenous Hernia.***—This, the second most frequent indication for resection, must be treated separately. The operation has now to be undertaken under different conditions from that under which removal of a new growth is performed. We have seen (p. 385) that then it is always best to defer resection of the intestine, if possible, until obstruction has passed away under medical treatment, or has been met by a colotomy, the surgeon choosing his time when the patient's general condition of strength and nutrition, and the local state of the bowel, are alike rendered as favourable as may be for meeting the calls of a severe plastic operation. In resection for gangrenous hernia, the conditions both of the patient and the intestine to be operated on are very different. Before describing the actual operation I would say that no absolute rules can be laid down here. Relief of a strangulated hernia is one of those operations of emergency, sometimes admitting of no delay, which any general practitioner must undertake, often under very unfavourable surroundings. It would be most unfair to expect that such a man, when face to face with a gangrenous hernia, should meet it in the same way as a hospital surgeon, able to command the very best surroundings, abundant help, and himself experienced in intestinal surgery. As I have said at p. 49, when the condition of the patient, the experience of the operator, and his surroundings admit of his taking this step, resection of the gangrenous intestine should always be performed. Where the above conditions are absent, the operator must rest content with enlarging the wound,† drawing all the gangrenous intestine well outside the peritoneal sac, opening and draining it thoroughly by one of the means given at p. 346. This will avoid the terrible risks of a continuance of paralysis of the bowel, stercoraceous vomiting, exhaustion, or *toxæmia*. The loop must be kept outside by a sterilised bougie or glass rod, as in inguinal colotomy (p. 128), aided by a few sutures. Any gangrenous omentum must be removed, and the sac cleansed as far as possible.

* The following are some of the most useful papers on this subject:—Lockwood (*Med.-Chir. Trans.*, vols. lxxiv. and lxxvii.); W. A. Lane (*Clin. Soc. Trans.*, vol. xxiv. p. 102); McCosh—three cases treated successfully by circular enterorrhaphy (*Ann. of Surg.*, vol. i. 1894, p. 647); Ransohoff (*ibid.*, vol. i. 1892); Mickulicz (*Berl. Klin. Woch.*, Nov. 10, 1892); Riedel (*Deut. Med. Woch.*, 1883, No. 45); Reichel (*Deut. Med. Woch.*, 1883, No. 45); Zeidler (*Cent. f. Chir.*, Jan. 16, 1893, p. 62); Caird (*Edin. Med. Journ.*, 1895, p. 312); Gibson (*Ann. of Surg.*, Oct. and Nov. 1900); Barker (*Lancet*, 1903, vol. i. p. 1579).

† In a very few cases, where the surroundings are even more unfavourable, the operator may have to be content with simply opening the bowel and doing no more (p. 49).

Gibson (*loc. cit.*) gives the mortality of primary resection and end to end union as 26 per cent. and that of artificial anus formation as 53 per cent., but these figures must not be accepted too readily, for the most severe cases are often considered to be unsuitable for resection, and artificial anus is made as a last resort in such cases.

Operation.—The intestine being found to be gangrenous, the extent of this must be first made out. It is possible that in a few cases the mischief may be so circumscribed as to involve only part of the circumference of the bowel. Here the resection of a very small portion of bowel is required; while in some it may prove sufficient merely to invert and suture the margin of the aperture, and it is possible to accomplish this through the original wound. Successful cases of partial resection are recorded by Sachs (*Deut. Zeit. f. Chir.*, Bd. xxxii. S. 93); Barette (*Thèse de Paris*, 1883, "De l'Intervention Chirurgicale dans les Hernies"); Lindner (*Berl. Klin. Woch.*, 1891, p. 277). One or two cases have also been recorded in America, but such circumscribed mischief is very rarely met with, and, where such limited resection is practised, care must be taken to place the sutures in healthy tissues. Five cases of partial gangrene of the intestine treated by inversion of the gangrenous or ruptured portion are very briefly given in an instructive but very short paper by Mr. Caird (*Edin. Med. Journ.*, 1895, p. 312):

All five were cases of hernia. There was a "perforation" of the intestine in one, and a "rupture" in two. Of the five cases, three recovered. Of the two which died, one was an infant aged 18 months. The necropsy showed firm union of the intestine without peritonitis. "The intestine was beset with typhoid ulcers of ten or fourteen days' duration."

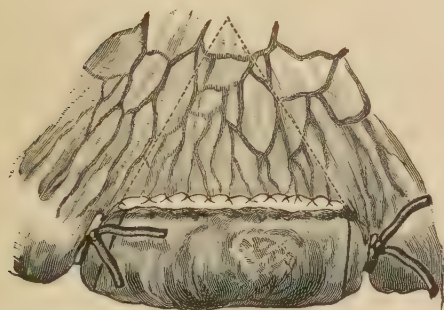
The following is Mr. Caird's advice as to the treatment of gangrenous intestine by inversion, and the cases suitable to this method: "If we meet with the typical elliptical necrosis of the bowel which runs longitudinally opposite the mesenteric attachment, we may, with Lembert's sutures, stitch the sound tissues over the unhealthy, thus inverting the gangrenous area into the lumen. This practice, which obviates the necessity of cutting any part of the bowel away, and requires no special dexterity, is in all probability not applicable with safety where more than one-third of the circumference is destroyed. The fear of stricture ensuing rather determines us to resect in such cases. . . . The method of inversion, although easy, cannot be modified to meet the exigencies of every case. It does not lend itself to those instances in which the gut is almost completely divided by the tight grasp of a narrow femoral ring. The vitality of the proximal end has then been too severely tried to admit of such an experiment. We should require to invaginate a few inches of the damaged gut before we came upon healthy tissue to suture; and since it is impracticable to reproduce the successful natural cure occasionally seen in cases of intussusception, we are driven to resect." If inversion be made use of, the greatest care must be taken, as in partial or complete resection, to ensure that the sutures lie in healthy tissues.

Mr. Makins (*Clin. Soc. Trans.*, vol. xxxvi. p. 183) also draws attention to the value of inversion in some cases; he records two successful operations, in one of which an area three-quarters of an inch in diameter was inverted.

Far commoner conditions are: (1) Where a whole loop or knuckle is gangrenous; (2) while the loop may appear fairly healthy, at its neck (where the pressure has been exerted), one or two pressure-furrows or lines of ulceration are present, and the greatest care must be taken in drawing this part of the bowel down, or its contents may escape into the peritonæal sac. (3) The gangrene extends over the convexity of the loop. In these last three, free resection passing through healthy tissues will be required.

The first question that arises when resection is determined upon is whether we should carry it out through the original wound enlarged, or through a second in the abdominal wall. The answer to this must depend mainly upon the variety of the hernia and the means adopted

FIG. 141.



Two different ways of dealing with the mesentery in resection of the intestine are here shown. In one the bowel is detached from the mesentery a little above their junction, all bleeding points being carefully tied, or the two folds of the mesentery united with a fine continuous suture. The dotted outline of the wedge shows the other mode of dealing with the mesentery. Drainage-tubes are used as clamps. (Esmarch and Kowalzig.)

FIG. 142.



Here the resected ends are shown sutured, and the edges of the redundant fold of mesentery which is present where no wedge is removed are being united with a continuous suture. Note that here and in Fig. 145 the union of the bowel and the mesentery is continuous across the triangular interval at the junction of the two. (Esmarch and Kowalzig.)

for uniting the resected ends. Where union by suturing is adopted, especially in umbilical or inguinal hernia, it will be sufficient to enlarge the wound if necessary either to allow an exclusive resection to be carried out, or to facilitate the reduction of the sutured intestine and the bulky mesentery.

In femoral hernia it is wise to make a fresh incision through the lower part of the corresponding rectus sheath,* unless the amount of bowel to be removed is very small. This is better than to have to

* Mr W. A. Lane made use of a median incision in two cases in which he resected gangrenous hernia, and united the intestine by means of Senn's plates and lateral anastomosis. One patient made a good recovery; the other, whose condition was very grave at the time of operation, died on the fifth day, and the necropsy showed a perforated gangrenous patch on the upper piece of the intestine (*Clin. Soc. Trans.*, vol. xxiv. p. 182).

divide Poupart's ligament, in order to get a proper view of the damaged bowel above the obstruction. This ligament will have to be divided if the resection is completed below the femoral canal, otherwise it will not be possible to reduce the sutured bowel and the mass of mesentery without exerting undue force. Barker (*Lancet*, 1903, vol. i. p. 1579) was compelled to sever Poupart's ligament on this account after the resection of eighteen inches of small intestine; a large hernia developed at the site of the operation and had to be treated by another operation two and a half years later (*Clin. Soc. Trans.*, 1905, p. 136).

A hernia is not likely to form at the abdominal wound which should be valvular, and should be sutured with due care. The adoption of this second incision will, of course, involve a risk of carrying infection into the peritonæal sac and the abdominal wound, and every precaution must be taken to lessen this danger, which has been exaggerated.

Any gangrenous or septic omentum having been tied off and removed, the sac and damaged intestine are carefully cleansed with perchloride of mercury solution (1 in 5000), any opening in the bowel being temporarily but firmly closed. If this is not possible the mesentery should be tied, and the gangrenous loop excised, the divided ends being cleansed, tied and covered with antiseptic gauze, and drawn upwards and out through the abdominal wound.

The second question concerns the *length of bowel to be resected*.—Care should be taken to remove too much rather than too little, for we find in many of the fatal cases reported that the cause of death was attributed to gangrene spreading upwards above the seat of suture; on the other hand, we find that recovery has followed when large portions of the intestine have been removed. Thus, Ramdohr excised two feet; Rydyggier had a case in which 54 centimetres were sacrificed; Rushton Parker cut out twelve inches; Walter also removed two feet four inches; and, lastly, Kocher had a patient who left the hospital perfectly well on the eighteenth day, after having had about five and a quarter feet of intestine removed. All these patients recovered (Kendal Franks, *Lancet*, vol. i. 1893, p. 1387).

Barker (*Lancet*, 1903, vol. i. p. 1579) has successfully resected over six feet of small intestine for gangrene of a loop due to femoral hernia in a woman of 63 years. Peck (*Ann. of Surg.*, 1903, vol. xxxviii. p. 451) removed eight and a half feet of gangrenous small intestine without any subsequent loss of nutrition during the succeeding two years; at the end of this time an operation was performed for the relief of a ventral hernia, and the bowel was examined and found to be normal in appearance, no sign of the line of union being seen. Kocher quotes Monari to the effect that up to seven-eighths of the intestine of animals may be removed without harm, and Roux has recorded the case of a patient who survived with only five feet of small intestine and half the length of his large intestine (Kocher, *Oper. Surg.*, p. 260).

In any variety of strangulated hernia, the intestine above the obstruction must be examined, and the site for the upper line of section should be chosen with great care. The lower section may be within two inches of the lower constriction.

No paralysed, congested, or greatly distended bowel should be left behind; failure to remove enough may lead to death from toxæmia,

paralytic distension, enteritis, or peritonitis, the latter being due either to sloughing of the upper end at the line of suture, or to infection of the peritonæum through the wall of the damaged intestine, without any visible perforation. Mr. Barker (*Lancet*, 1903, vol. i. p. 1579) has strongly advocated more extensive resections in all cases which need resection at all. Sound tissues may thus be obtained for suture, paralysed intestine in a condition of infective cellulitis may be removed, together with pints of poisonous contents, which would otherwise become absorbed to some extent with lethal effects.

Clairemont and Ranzi (*Ann. of Surg.*, 1903, vol. xxxviii. p. 914) have shown how poisonous these retained products are, and others have proved how virulent the bacillus coli becomes in cases of intestinal obstruction.

It is important to examine the mesentery to find out the condition of its blood vessels, the presence of pulsation and the absence of œdema or extravasation of blood being essential at the line of section.

Barker points out that an extensive resection takes very little more time than a small one, and that there is hardly any difference in the amount of shock induced; that nutrition is not impaired in resections up to six feet Barker and others have shown (*vide supra*).

Since adopting wider resections Mr. Barker has performed seven of these operations with only two deaths, and one of these was due to obstruction from an old fibrous band which pressed upon the intestine, after its return. The other was due to peritonitis probably due to infection from the sac which was not drained through the groin.

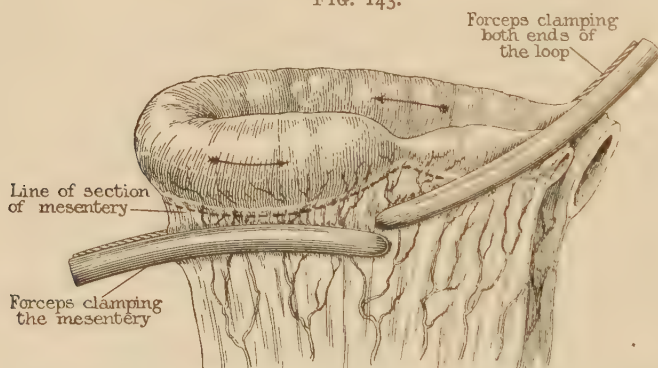
The rule must be, therefore, to remove every atom of suspicious bowel, and to cut through and place the sutures in healthy tissues.* It would seem from published cases that the mesentery may with equal success be treated as in Fig. 139, by excision of a wedge, or as in Figs. 141, 144. In this latter case the mesentery is divided as close to the bowel as possible. As, however, more time is occupied by the removal of a wedge, since many more vessels have to be tied, and as there is no corresponding advantage gained by so doing, the simpler plan of uniting the cut edges as in Figs. 142 and 144 is to be preferred.

The intestine to be removed is drawn well out of the wound, and its base surrounded with gauze packing to protect the peritonæum. The two ends of the loop are placed together and clamped with a single pair of Doyen's long clamp forceps, as advised by Mr. Barker (*loc. supra cit.*)

* Lockwood gives the useful hint to cut through the collapsed distal end first, as the gangrenous portion and the distended end may then be drawn further from the wound, and used as a spout to carry off the fæcal accumulation (*Med.-Chir. Trans.*, vol. lxxiv. p. 213). Caird (*Edin. Med. Journ.*, vol. ii. 1895, p. 314) advises thus on this point: The peritonæum being well shut off, "just beyond the *distal* end of the gangrenous mass a couple of long-bladed pressure-forceps should be applied side by side, and the gut completely divided between them. The mesentery should now be severed along its attachment to the portion of gut we wish to remove, and this enables us to hold the free extremity over a vessel, when, on removing the forceps, the contents escape and the congestion abates. Having thus relieved the congestion and emptied the gut, we may now reapply the forceps on the central healthy gut, and cut away the intervening damaged portion." Mr. Caird considers that if the pressure-forceps have inflicted any permanent damage on the cut margin of the gut that edge becomes inverted, thanks to the Lembert's sutures (*vide infra*).

and shown in the figures. Traction is then made upon the middle of the loop to get the mesentery taut and free of folds, and the two layers are clamped together with another pair of long clamps, whose points should reach that of the first pair if possible. If the resection is very extensive, a third pair of clamps may be applied to the remainder of the wide mesentery, by thrusting one of its blades through both layers near the tip of the second pair. The mesentery is divided between the clamps and the intestine, and the proximal end of the loop is liberated from the first clamp, which should still hold the distal end and both mesenteries. A fresh clamp is placed near the distal end of the loop, which is then divided between the two clamps, and brought away from the wound and liberated over a basin at the side of the table. While the contents of the intestine are being drained away as far as possible, the two layers of the mesentery are sewn together with mattress sutures of silk, each suture securing about two-thirds of an inch of the two

FIG. 143.



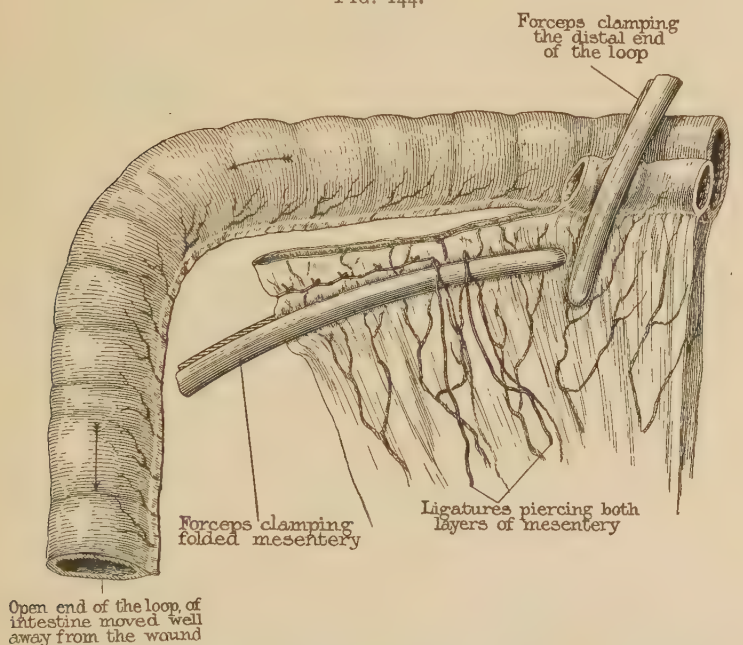
Resection of gangrenous intestine ; The blades of the forceps clamping the intestine should be sheathed with rubber. The folded loop here represented is for convenience of drawing only a short one. (After Barker, *Lancet*, vol. i. 1903.)

membranes. The intestinal ends if unequal in calibre are placed and clamped together obliquely, so that more may be removed from the convex border of the smaller one, in order to equalise the sections to facilitate the suturing. The projecting pieces are then shaved off, close to the clamp forceps, and another clamp is applied to both tubes parallel with the first but nearer the body. The first is then removed, leaving one-third of an inch of each extremity projecting beyond the second clamp. The ends are joined together by a continuous catgut suture which pierces all the coats, and inverts the edges, all knots being tied so that they be within the bowel. If another layer is considered necessary the clamp should be moved further away to allow inversion to be produced by means of a continuous Lembert or Cushing suture; an omental graft may be applied in some cases. Mr. Barker's method of resection of gangrenous bowel is a good and speedy one; and in these cases time is of immense importance. It must not be forgotten, however, that careful and accurate sewing is of even greater importance (*vide*, Figs. 143, 144, and 145).

Murphy's button or bone bobbin may be preferred by some surgeons

on account of the ease and rapidity of introduction, but I prefer to trust to direct suture, believing that this method is the best if well carried out, and with practice it can be performed in from 10—15 minutes; it needs more care than a button, however, and it is certain that the button has given very good results in the past. Gibson (*Ann. of Surg.*, 1900) found the mortality of resection and primary reunion by suture to be 38 per cent., and that of the same procedure with the aid of the Murphy button to be only 30 per cent., but these figures refer to the ten years ending in 1898, and since then the technique of direct suture has improved greatly. Circular enterorrhaphy is safer and more satisfactory in every way than lateral anastomosis.

FIG. 144.



As the sac will almost certainly have been septic, drainage should be employed.

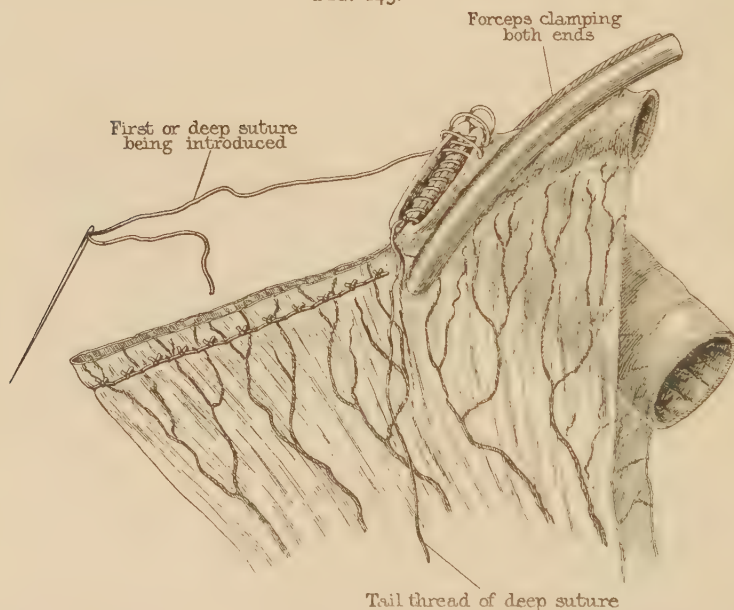
The question of the advisability of attempting a radical cure now arises. Very often this will be forbidden by the general condition of the patient. Whenever there is any risk of septic infection, or any doubt as to the efficiency of the suture, the wound must be kept open. Mikulicz, if I understand him rightly (*loc. supra cit.*), leaves these cases open.

If any extravasation have taken place into the peritonæal sac, this must be cleansed, and drainage employed as advised at pp. 326, 339.

It may be convenient to briefly recapitulate here the chief courses open in the treatment of gangrenous hernia. (1) Leaving things alone

(p. 49) ; a course only to be adopted when the condition of the patient and the surroundings of the surgeon do not admit of more being done. (2) Primary resection either of a portion of a coil, as in a gunshot wound, or more usually of the whole loop. (3) Intermediate resection (Riedel, *Deut. Med. Woch.*, 1883, No. 45). Resection is performed, an artificial anus established, and after twenty-four or forty-eight hours the edges of the intestine are vivified and united by suture. (4) Enterostomy, or the making of an artificial anus and the closure of this at a subsequent date. In cases where the collapse of a patient demands prompt termination of the operation, the surgeon should

FIG. 145.



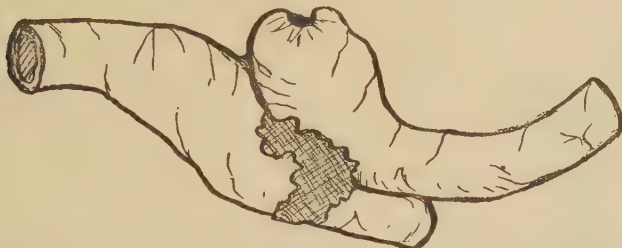
Resection of gangrenous intestine. The loop has been removed and the healthy ends are being joined together ; the continuous deep suture is being introduced. Note that the distal end is clamped obliquely so as to make the section equal to the dilated proximal end. (After Barker.)

insert two Paul's tubes in the ends of the intestine, keeping these well outside (Fig. 135). The artificial anus must be closed later on (p. 414). In any case in which I was not satisfied as to the completeness and efficacy of the sutures, I should prefer to place the sutured bowel just within the abdomen, and leave a temporary drain reaching down near to the line of suture. Packing around the coil interferes with natural reinforcement from adhesion to neighbouring coils. In twenty-four or thirty-six hours it will be safe to remove the gauze drain and to close the wound by means of provisional sutures inserted at the time of the operation. Or the following precaution may be adopted.

Omental Grafting (Figs. 146, 147, and 148).—This is one of those details in intestinal surgery which we owe to Senn. To strengthen a weak spot or line of union a strip of omentum is torn, not cut, from the

free end of the omentum, laid over the spot which it is intended to strengthen, and secured with a few sutures. The contiguous surfaces may first be lightly scarified, short of causing bleeding. Another method, that of leaving the graft attached by one end, should not be

FIG. 146.



Ileo-ileostomy, with Senn's plates, completed. An omental graft has been placed over the line of union. From a specimen removed from a dog some time after recovery. (Jessett.)

adopted, as this may, later, bring about ill results in the form of intestinal obstruction.

In the after-treatment of resection cases collapse must be vigorously combated, feeding by the bowel trusted to for thirty-six or forty-eight hours, and as little morphine or opium given as possible, for fear of

FIG. 147.



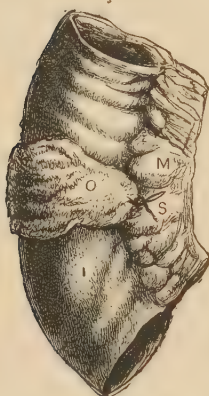
Ileo-colostomy. The line of implantation of the small into the large intestine has been covered with an omental graft. From a specimen removed from a dog some time after recovery. (Jessett.)

“conducting to further, and perhaps fatal, intestinal paralysis” (Lockwood). Flatus will probably be passed in forty-eight hours, and the bowels act between the fourth and six days.

Treatment of Intestine which is Dangerous though not actually Gangrenous.—Before leaving the subject of gangrenous intestine in hernia, and its treatment, there is one remaining allied class of hernia often very fatal, for which modern surgery may do much, viz., that in which the condition of the bowel is such that, though gangrene is not

yet present, this may set in if the bowel be returned into the abdomen. In Ransohoff's words (*loc. supra cit.*; *Ann of Surg.*, vol. ii. 1892, p. 349), "Such a knuckle is a menace. Bowel that is not at all doubtful in appearance will at times repay the trust placed in it by a perforation. Among ninety-six deaths after herniotomy it was, in

FIG. 148.



An omental graft secured in place over the line of an enterorrhaphy. I, Intestine. M, Mesentery. O, Graft. S, Suture fixing graft. (Walsham.)

twenty-six cases, the result of returning intestine which subsequently perforated. To return doubtful intestine is necessarily jeopardising life. To treat such intestine as radically as bowel already gangrenous is an extreme measure not to be advocated. Fortunately the intestine can be retained in the wound for a number of days in gauze packing or by sutures. When its viability has been established it is an easy matter to return it into the abdomen." Graefe has reported (*Deut. Zeit. f. Chir.*, Bd. xxxiv. S. 82) a successful case in which the intestine was so retained for five days before it was replaced.

While I entirely agree with Dr. Ransohoff in the principle of the above, I think he represents the returning of such intestine as unduly easy. Even after twenty-four or thirty-six hours, the earliest date at which it will be safe to return it, the intestine will be found adherent to the gauze and to bleed easily. Cases in which this difficulty arises should be quite rare at the present day, now that the principles that govern successful resection are better known. In any case of doubt, or when the surroundings or the condition of the patient do not allow a resection I should always empty the distended intestine as far as possible by means of a temporary enterostomy, a small tube being fixed at the convexity of the bowel, for this is the first essential step towards saving the patient's life. A few days later the fistula can be closed by inversion if the patient survives.

INTESTINAL ANASTOMOSIS. SHORT-CIRCUITING. LATERAL ANASTOMOSIS. UNILATERAL AND BILATERAL EXCLUSION.

The first two of the above-given terms have been often needlessly used for the same thing—viz., the establishment of a permanent fistulous opening between the bowel above and the bowel below some point of obstruction, usually a growth which cannot be removed.

By Lateral Anastomosis is meant the making of a fistulous opening between two parts of resected intestines, the two ends being first securely closed.

However end-to-end junction of resected intestine may ultimately be performed, it is certain that the above operations have a great future before them. The principle of them all, and the making them of

practical utility, we owe to the labours and experiments of Prof. Senn, and their elaboration is due largely to the work of Maisonneuve, Hartman, Mikulicz, Salzer, Monprofit, Lane and others.

Indications.—*Intestinal anastomosis or short-circuiting* are to replace resection where the general and local conditions forbid the severer step in such cases as—(a) Growth; for cases suitable for resection see p. 384. (b) Contraction, cicatricial and not malignant in character. (c) Matting of intestines by old mischief, perhaps dating to tubercular peritonitis, or inflammation about a caseous mesenteric gland. (d) An intussusception which is irreducible but not gangrenous. It has also been employed for the treatment of constipation and also for colitis and for some cases of volvulus.

Mayo Robson (*Lancet*, Sept. 27, 1902) has recorded some interesting and successful cases of enterectomy and short circuiting for tuberculosis of the intestine.

Advantages.—Prof. Senn claims the following, and with regard to the principle of intestinal anastomosis all will agree with him. As regards the details as to which method is the best, time alone will show. (1) That the operation can be rapidly performed with a great saving of time. (2) That the junction of the intestinal surfaces around the anastomosis is a safe one. (3) That the operation is independent of any difference in the size of the bowel above and below the obstruction. (4) That the principle is of very wide application. To these may be added: (5) That the opening may be made of any size that may be desired; (6) That there may not be any need to interfere with the mesentery.

But according to the experiments of Chlumsky side-to-side union is not so firm as that of end-to-end, and contraction of the orifice is more likely to follow it.

I. Anastomosis by Sutures alone (Figs. 149-153).—Most surgeons are abandoning artificial aids in anastomosis and preferring to trust to sutures alone, just as in end-to-end union they have returned to circular enterorrhaphy. The method of Abbe, which has given good results, is as follows: After resection of the intestine and closure of the two ends, the two segments of intestine are laid parallel with each other, and two rows of continuous Lembert's sutures are applied a quarter of an inch apart and an inch longer than the incision which it is proposed to make (Fig. 149). Each piece of silk (twenty-four inches long) is left at the end of its row, being still threaded. The bowel is then opened for four inches, a quarter of an inch from the sutures, both rows being to one side of the cut. Any vessels that bleed are treated by forcipressure. The opposite segment of bowel is then opened in the same way. The two adjacent cut edges are now united by a suture which traverses both the mucous and serous wall (Fig. 150), and so secures any bleeding points, the forceps being taken off as they are reached. The two free cut edges are secured with a similar "whipping" stitch, after which the serous surfaces on the opposite side of the opening are approximated and secured by continuous Lembert's sutures, the first threads securing this purpose. It is claimed that this method requires little, if any, longer time than that with mechanical supports of any kind, and that it is free from many of their disadvantages, viz., the need of special apparatus, foreign bodies which have to come away,

contraction of the opening, which is here so very free, and the prolapse of the mucous membrane through the opening.

Abbe's method is not an ideal one because the edges of the whole circumference of the orifice are not secured together by means of a stitch which pierces the whole thickness of the intestinal walls, which is a desideratum in all forms of intestinal union. Moreover the method of catching the vessels with forceps is not so good, simple and easy as by clamp forceps in the following adaptation of Moynihan's method of gastro-jejunostomy.

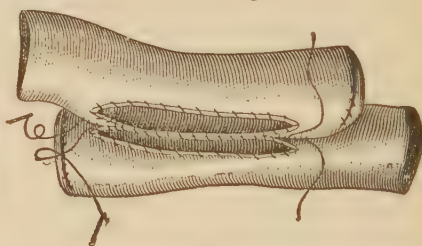
II.—The two chosen loops or inverted ends are brought well out of the abdominal cavity and the latter protected by gauze packing. A suitable length and width of the antemesenteric part of each bowel is emptied with the fingers and clamped with Doyen's pliable *curved* forceps sheathed with rubber. The rest of the prolapsed loops having been returned or covered with gauze and a sterile swab placed between them, the forceps are approximated and a continuous silk suture is inserted to join the touching edges of the clamped portions of bowel for

FIG. 149.



Abbe's method of anastomosis by sutures only. To show the suturing of the intestine before the incision is made. (*American Text-book of Surgery.*)

FIG. 150.



To show the four-inch openings and the sewing of the edges. (*American Text-book of Surgery.*)

a distance of three inches. Longitudinal incisions two and a half inches long are then made through the serous and muscular coats of the exposed pieces of intestine, and the elliptical pieces of mucous membrane which protrude are removed with scissors. The mucous membrane is thoroughly cleansed with solution of lysol, and a continuous catgut suture is used to unite the edges. The needle must pierce all the coats, and the insertions should be only about one-eighth of an inch apart, so that the thread may prevent any bleeding, as well as secure the edges firmly together. The knot should be upon the mucous surface so as to prevent infection at this otherwise likely spot (*vide* p. 359). The clamps are then removed, and the continuous sero-muscular stitch is again taken up to complete the circle of peritoneal apposition around the aperture. The width of this apposition should be about one quarter of an inch.

III.—Dr. Halsted has described another method of intestinal anastomosis by suture only (*Bulletins Johns Hopkins Hospital*, vol. ii. No. 10). He prefers quilt or square sutures (Figs. 151 to 153) because one row is sufficient, and they tear out less easily and constrict the tissues less than do the Lembert's sutures. The following are the steps of this method. The two selected portions of intestine having been placed

in contact along their mesenteric borders, six square sutures are put in a straight row, tied, and cut short. At each end of this, the posterior row of sutures, and nearer the free border, two lateral square sutures are applied (Fig. 152), tied, and cut short. Eight or nine square sutures are now applied so as to draw together the free borders. These sutures are not, however, tied, but drawn aside (Fig. 153), so as to make room for the scissors with which the two segments of intestine are opened. Finally, the sutures of the anterior row are tied and cut short.

FIG. 151.

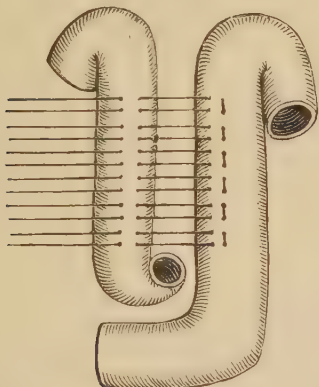
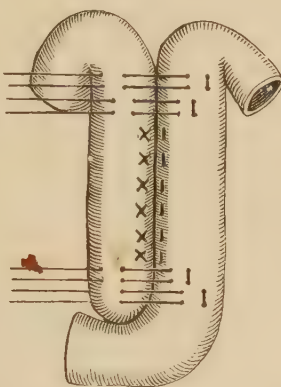
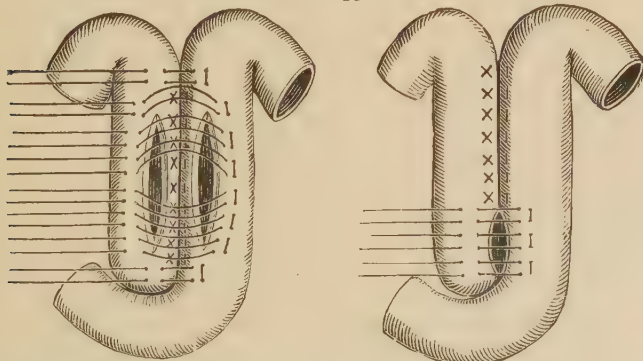


FIG. 152.



Method of lateral anastomosis by Halsted's simple suturing. The sutures are of the square kind. Fig. 151, first stage; Fig. 152, second stage. (Jessett, from Halsted.)

FIG. 153.

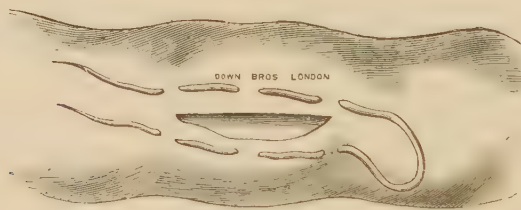


Halsted's operation, third and fourth stages. (Jessett, from Halsted.)

Mr. Bidwell (*Brit. Med. Journ.*, vol. i. 1902, p. 322) uses this method for performing ileo-sigmoidostomy for irremovable growth of the colon. He does not use any intestinal clamp, but ties the ileum at two places by means of thin rubber tubing so as to avoid damaging the distended bowel in cases of obstruction, but properly applied clamps are better. Halsted's stitch is very good as regards the outer coats, but I prefer to use a perforating stitch to secure the edges, and to supplement this with some form of continuous sero-muscular suture; the aperture is not so likely to contract after this method as after that of Halsted.

IV. Anastomosis with Murphy's Button (Fig. 158).—The technique here differs but little from that already given for end-to-end junction by this method. Similar spots in the ileum and cæcum having been chosen, a needle threaded with about a foot of silk is inserted in the long axis of the bowel as at Fig. 154; a stitch is taken through the entire wall of the bowel, one-third the length of the incision to be made; the needle is again inserted, one-third the length of the incision from its outlet, in a line with the first, and embracing the same amount of tissue. A loop, three inches long, is held here, and the needle is inserted in a similar manner, making two stitches parallel to the first in the reverse direction, and one-fourth of an inch from it, coming out at a point near the original insertion of the needle. This forms the running thread (Fig. 154) which, when tightened, draws the incised edge of the bowel within the cup of the button. A similar running thread is inserted in like fashion in the colon. Incisions two-thirds the length of the diameter of the button to be used are then made between the two running threads (Fig. 154), care being taken not to

FIG. 154.



This shows the method of passing the puckering thread when Murphy's button is used in lateral intestinal anastomosis, gastro-enterostomy, &c.

cut these, the female half of the button slipped into the ileum and the male into the colon, the running thread drawn tight and tied firmly round the central cylinders. While this is done, an assistant holds each half in place, and care is taken that the intestine is held evenly all round the cylinder in the grip of the ligature. The two halves of the button, next held in the fingers, are firmly pressed together until the serous surfaces are in accurate contact all round and at every point. A few reinforcing mattress sutures may be inserted if considered necessary. The use of the button has not been attended with great success in short circuiting for obstruction by irremovable growth; it has not uncommonly led to leakage from sloughing (Bidwell, *loc. cit.*). Mayo Robson's bobbin or that of Stanmore Bishop may be used more safely. These contrivances are especially suitable when it is not possible to withdraw the intestine from the abdomen; but they are slippery to handle, and they are difficult to decalcify evenly, so that some parts are absorbed before others.

V. Anastomosis with the Elastic Ligature of McGraw (*Amer. Med.*, Aug. 3, 1901) (*vide* Figs. 208 to 210, p. 521).—The two loops are brought together and joined by means of a continuous Lembert silk suture, running for a distance of three inches in a semilunar curve,

along the length of the loops and one-third of an inch away from their free borders.

An elastic ligature two or three millimetres in diameter and threaded on a suitable and long straight needle is then passed twice through the walls of first one and then the other bowel at the free borders. The ligature must not run transversely but longitudinally in the intestine, and it should take a bite of from one and a half to two inches; it should be both threaded and passed while upon the stretch, so that when it contracts it may entirely fill the perforations in the intestine to prevent any leakage. The needle should be held at right angles to the bowel during its insertion, so that it may pierce the mucosa, and not leave any bridges uncompressed by the ligature. When the ligature is tightened and twisted into a single knot, the latter is secured by means of a silk ligature tied around it. The ends are then cut short, and the circle of Lembert suture is completed around the ligatures (*vide* Fig. 210, p. 523). Dudley Tait (*Ann. of Surg.*, 1906, vol. xliii. p. 190) recommends a simpler method. The ligature is held upon the stretch, clamped close to the bowel, and then tied beneath the clamp. The ends can be cut without fear of the knot slipping. It is claimed that this method is very rapid and simple, and that it carries less risk of sepsis and shock than any other plan, also that it can be as quickly used as a Murphy button, but without the risks of leaving a dangerous foreign body in the intestine.

Dudley Tait has shown by his experiments upon animals that the stoma which is made by the elastic ligature is large and clean cut, and that subsequent contraction is unlikely even when an alternative passage remains open. If the ligature break or be not tight enough, the anastomosis fails or is imperfect, but these accidents are avoidable. It is, however, utterly unsuitable for cases of intestinal obstruction which require immediate drainage, for the ligature does not cut out and provide an opening for several days; but* McGraw uses the ligature in combination with resection, the limbs of the loop to be excised being anastomosed, and the anastomosis returned just within the abdomen. The loop is then resected and the ends drained until the anastomosis is well established.

Meyer,† Murphy,‡ Oschner,§ and other American surgeons, speak highly of the ligature method, especially for gastro-jejunostomy. Oschner has performed forty gastro-jejunostomies without any ill effects arising from the use of the ligature, but it must not be used if the pylorus is obstructed. Personally I prefer the direct suture method to any other, because a firm union and a free opening are established at once and nothing is left to chance or to sloughing.

INTESTINAL EXCLUSION.

Mere anastomosis may not be enough in some cases, and it may be desirable to go further and "exclude" a portion of diseased intestine,

* McGraw (*Ann. of Surg.*, 1904, vol. xi. p. 688).

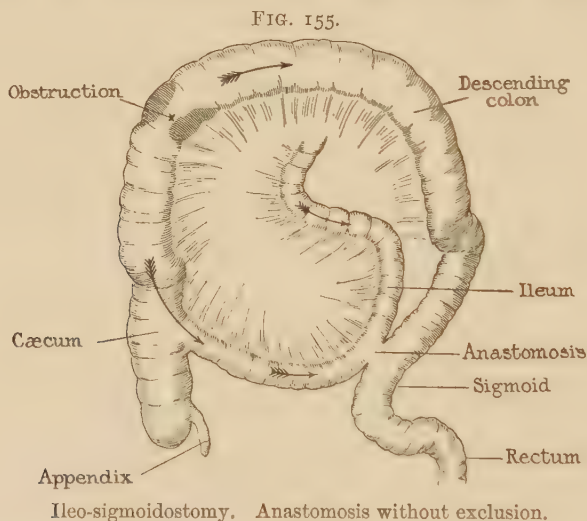
† *Med. Record*, Jan. 25, 1902.

‡ *Bost. Med. and Surg. Journ.*, Jan. 28, 1904.

§ *Ann. of Surg.*, 1904, vol. xxxix., p. 144.

so that the fæces may not reach and irritate that part, or get retained within it. Thus, in cases of colitis or tuberculous disease or growth, it is desirable to give the diseased part as complete rest as possible, and in chronic constipation, anastomosis alone will not prevent fæcal accumulation in the cæcum and colon. Moreover, it is not only necessary to divert the stream completely for these reasons, but also to prevent the contraction of the new orifice, which may occur, if an alternative course is left open.*

Unilateral exclusion involves complete division of the intestine above the disease, with anastomosis or implantation of the proximal end into the side of the healthy intestine below; the distal extremity may be either closed or drained according to the necessity; it is generally



closed. For example, the ileum may be cut across near the cæcum, and the upper segment joined to the sigmoid colon, the cæcal end of the ileum being inverted or drained (Fig. 156).

Operation.—Mr. Arbuthnot Lane's method of performing ileo-sigmoidostomy is described here as an example, but other parts may be joined in a similar way according to the requirements in any given case. The ileum about six inches from the cæcum is clamped with two pairs of crushing forceps, which are placed transversely across the intestine at a distance of one inch from each other. The forceps serve to break the muscular and mucous coats which retract, but the peritonæal covering and fibrous tissues are not torn, but are ligatured after the forceps have been removed and have left a deep constriction. The empty piece of intestine between the two ligatures is then excised and its mesentery tied. The comparatively small stumps are inverted by means of a purse-string sero-muscular silk suture. Doyen showed the advantages and safety of this rapid and simple method of closing divided bowel. A lateral anastomosis is now made between the proximal segment of the ileum and the side of the sigmoid loop of

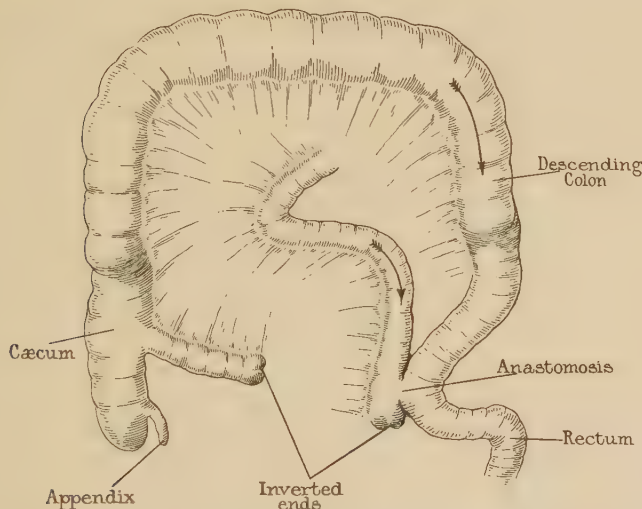
* Summers (*Ann. of Surg.*, 1905, p. 99).

colon, both of which are suitably clamped and brought outside the abdomen, so that the peritonæum can be protected with gauze tampons. Two continuous silk sutures are used, a deep one piercing all the coats, and the other only including and inverting the serous and muscular coats.

This plan has been recommended for the treatment of certain cases of chronic colitis, but for it to be efficient, the sigmoid colon at and below the anastomosis must be healthy, which may not be the case in dysentery and other forms of colitis. Another objection is that fæces may still find their way into the cæcum by reverse peristalsis (Cannon, *loc. infra cit.*).

Summers (*loc. supra cit.*) records three cases treated in this way, and in these no reflux was noticed, but this may have been at least

FIG. 156.



Unilateral exclusion. The ileum has been cut across, its ends inverted, and the proximal part anastomosed to the sigmoid colon.

partly due to the Gibson valvular fistula that was made into the cæcum in two of these cases.

In combination with appendicostomy or cæcal fistula this plan may be found to be useful in some cases, for the colon can be washed out in case of need (pp. 138 and 140).

Chronic constipation (*Lancet*, vol. ii. 1904, p. 1695, and vol. ii. 1905, p. 862).—Mr. Arbuthnot Lane has practised this operation for chronic constipation, with the object of preventing the accumulation and decomposition of fæces in the cæcum and colon. A mere entero-anastomosis does not prevent the fæces from reaching the cæcum through the ileum, and moreover the new orifice may close in the absence of obstruction in the course of the large intestine. Unfortunately regurgitation may still take place after unilateral exclusion, the antiperistaltic waves of contraction carrying the contents of the sigmoid colon backwards into the cæcum. Cannon (*Amer. Journ. of*

Physiology, 1902) proved by means of the X-rays that enemata containing bismuth were taken to the cæcum by antiperistalsis, and clinical experience has shown that the cæcum may fill with fæces, in time, after unilateral exclusion. Enemata may be of no avail then, and purgatives cannot be expected to act, unless a satisfactory drug can be discovered for exhibition through the blood stream. The result is that in some patients the greater part of the colon has been resected in order to relieve the patient of pain. Appendicostomy, or Gibson's valvular cæcostomy may remove the necessity of this heroic treatment by allowing the introduction of fluid or purgatives. It was at first expected that diarrhœa might be troublesome after joining the ileum to the lower sigmoid or rectum, but experiments on animals and clinical experience have shown that this does not occur except as a very temporary annoyance. Within a few weeks the bowels may be acting once or twice a day with regularity; but unfortunately as time goes on constipation may return, and this is true to a lesser degree even after resection of the colon in some cases. Whether time and results will prove these operations to be of value in the treatment of colitis and constipation is an open question.

My friend Dr. Sheaf has kindly allowed me to read his thesis upon this subject, and he concludes that ileo-sigmoidostomy is not much good for women with chronic constipation, but that it is more hopeful for men. Colectomy, although it is attended with severe shock, and is more dangerous, affords far better prospect of cure or of marked relief, most of the patients having improved greatly in their general health after this operation. "But the results are, on the whole, disappointing, many of the patients being of such poor fibre and neurotic temperament that nothing can make them healthy citizens. The disease is often the result of careless habits, which will remain after the operation."

Personally I regard less drastic measures with more favour, and believe that very few cases of constipation are not amenable to treatment by means of proper dieting habit, muscular exercises, massage of the colon, a sufficiency of fluid, and such drugs as belladonna, aloes and nux vomica. In cases of real mechanical obstruction, unilateral exclusion is a recognised surgical proceeding. Appendicostomy, as suggested by Mr. Keetley, is an alternative treatment for constipation, and being less severe and dangerous than unilateral exclusion it is certainly worthy of trial in preference to ileo-sigmoidostomy, which may ultimately lead to resection of the colon. Moreover, appendicostomy provides an opening which does not leak, and yet allows the introduction of fluid or drugs into the colon in order to secure an evacuation. In Mr. Keetley's published case, this plan acted admirably. Cannon (*loc. cit.*) and Goddard (*Lancet*, vol. i. 1905, p. 795) have shown that absorption of fat, carbohydrates and fluid occur to an appreciable extent in the cæcum and colon, but it is certain that these functions can be replaced by the small intestine.

Many pathologists of large experience have not observed the adhesions that Mr. Lane has described from his clinical experience, and Dr. A. Barrs (*Lancet*, vol. ii. 1904, p. 1888) in a trenchant criticism of operative treatment for constipation states that, "looking back over eleven years of post-mortem work in a large general hospital, I cannot recall one case where the changes described by Mr. Lane were seen to result

from obstinate constipation." He then refers to Dr. Goodhart's views upon this subject as follows:—

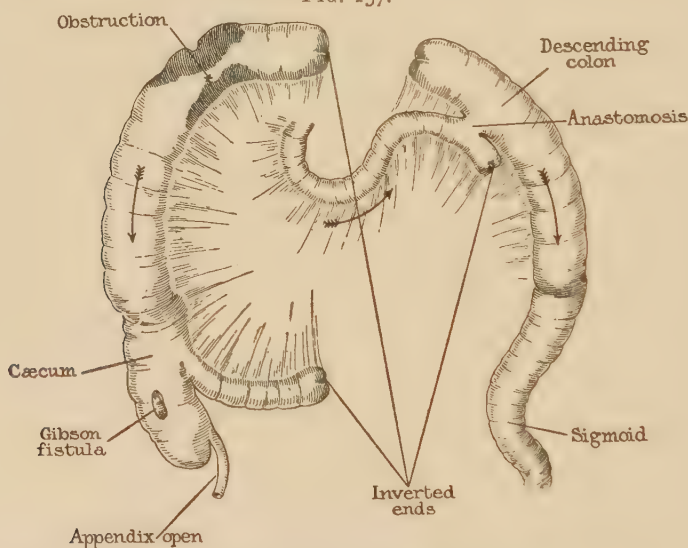
"But better criticism than any I can make is to be found in an address, 'Round about Constipation,' by Dr. J. F. Goodhart, and, if I may be permitted to do so, I will quote from it a few remarks which directly traverse many of Mr. Lane's contentions and at the same time recount nothing more than the everyday experience of most of us. Dr. Goodhart says: (1) "A mere adhesion, such as seems often to be accepted as a sufficient explanation of obstruction of the pylorus or intestine, I have little belief in, because you rarely, I think, find such localised adhesions in the post-mortem room where there has been any evidence of their presence during the life of the patient." (2) "There are many people who live through their adult life in the belief that if the bowels do not act for two or three days they will get a block—that is, there will come obstruction of the bowels. So many of us act, too, as if we believe it, that we encourage the same doctrine. But it is not a fact. I can say positively that in thirty-five years of work I have only seen one case of this kind and in consequence I made a wrong diagnosis." (3) "A mere intestinal accumulation never produces obstruction." (4) "I have often been struck with the fact that of all of those who suffer from constipation how few there are who give any sign of retention." Lastly, speaking of intestinal auto-intoxication, to which Mr. Lane attributes many of the symptoms he enumerates, Dr. Goodhart says: "I think the time has come to make a protest when we are becoming overridden by the minuteness and ingenuity with which this doctrine is now elaborated. I hear of nothing now but auto-infection and auto-intoxication . . . and really one would almost think from the contumely that is heaped upon our uncomely colon, that the evil that it is supposed to do us, and the bits, and large bits too, of which it is now oftentimes bereft by the surgeon, that happy would be the man who could . . . live without it."

Many patients who suffer from chronic constipation are "nerve wrecks" or neurasthenics; whether their nervous condition is primary or secondary to the constipation is an open question, but I believe that the constipation is merely an incident in their history of aches and pains. Their nervous energy is barely equal to the demands made upon it by work or worry or both, so that in many cases constipation can be said to be a "mental preoccupation" disease, which is beyond the reach of surgery, but an operation, however, may generate hope and do some temporary good.

Recently one of us (R. P. R.) had a servant girl under his care, who complained that the bowels were not opened more than once a fortnight without medicine, and that she could not take any exercise because of the pain that she suffered. She had not done any work for two years. About that time the right kidney had been fixed, and had given temporary relief. The doctor who knew her from childhood wrote and said that he regarded her as a neurotic patient, and that her father also was a man of no courage, but shirked work on the slightest excuse. Drugs were tried and belladonna certainly gave some relief, but dieting could not be carried out properly for an out-patient, and she refused to take exercises. She clamoured for an operation, and having regard to the teaching of Lane, that constipation may be due to kinking of the hepatic flexure which may result from mobility of the kidney, or from the operative fixation of the latter, it was decided to explore. The operation was performed after a week's observation in hospital, during which time the bowels were not moved, but the patient ate freely of ordinary full diet. No purgatives

or enemata were given. At the operation, the cæcum and colon were first examined, especial attention being paid to the hepatic flexure and cæcum, but nothing abnormal could be discovered. The right kidney was quite fixed, the left had its normal degree of mobility. The liver was lower and more movable than normal. The intestine was nowhere distended or constricted, but seemed to be peculiarly empty considering the duration of the constipation. The stomach and pylorus were examined and they were normal. This examination was made, because of the common error of attributing constipation really due to disorders of the stomach or obstructions of the pylorus to diseases of the intestines. *The whole length of the intestine was examined*, especial care being taken to follow the duodenum; but no abnormality was noticed, beyond perhaps an unusual thinness of the wall of the ileum; but peristalsis could be seen to occur in it. There was no volvulus of the sigmoid colon, and there were no peritonæal adhesions anywhere. The appendix was normal, and the right ureter was also normal as far as it could be examined with the hand in the abdomen. The uterus and pelvic organs were

FIG. 157.



Bilateral exclusion. The excluded loop must be drained through the distal end, or through a cæcal or appendicular fistula.

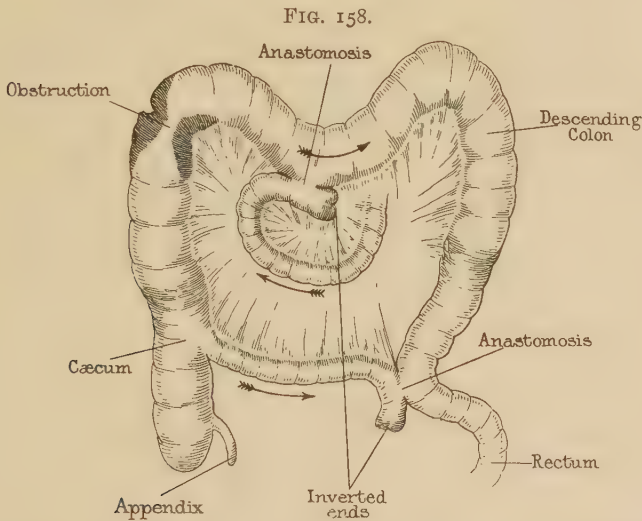
normal and not displaced in any way. There being no indication for ileo-colostomy or even for appendicostomy, the abdomen was closed. The patient made a rapid recovery, and she does not complain of any pain. The bowels are open once every day or every alternate day with the aid of a mixture containing five minims each of the tinctures of belladonna and nux vomica. The patient herself says that she is quite well now, and she is at work.

Some form of unilateral exclusion is done for irremovable growth of the colon; the objection to this is that accumulation of intestinal secretions and of discharges from the growth may occur above the obstruction in the excluded intestine, and this may lead to inflammation or even perforation; for this reason, simple entero-anastomosis is to be preferred in cases of growth, and it also takes less time, which is important in cases of intestinal obstruction.

Bilateral exclusion (Fig. 157) involves two divisions of the intestine, above and below the growth or disease, the central and peripheral ends being joined together. The ends of the excluded loop

can be inverted or drained at one or both extremities ; the distal extremity should usually be chosen for drainage because peristalsis will then aid it. In case of obstruction, however, the fistula should be proximal to the obstruction. A valvular cæcostomy or an appendicostomy may serve admirably for draining an excluded cæcum and ascending colon in case of irremovable growth of the latter, for which bilateral exclusion has been performed.

It is not safe to close an excluded loop entirely, especially if the intestine is diseased. **The exclusion with drainage into the intestine** of Monprofit is to be preferred to bilateral exclusion with drainage on to the surface. Intestinal exclusion in one form or another has a wide range of possible application, and is pregnant with possibilities. Summer gives the following example of Monprofit's method. With an

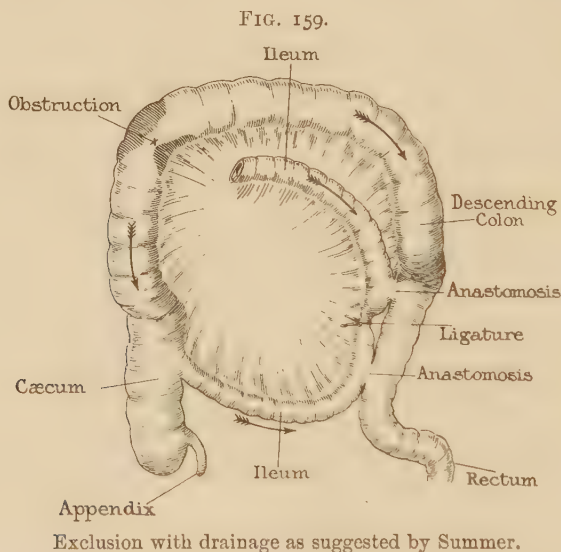


Exclusion with drainage. The proximal part of the ileum has been joined to the transverse colon, the distal part to the sigmoid loop.

irremovable obstruction by growth in the ascending colon, the ileum may be severed, and its proximal segment joined to the sigmoid flexure, and the distal or cæcal extremity implanted into the side of the transverse or descending colon (Fig. 158). Clinical experience has shown that the ileo-cæcal valve does not prevent the passage of the contents of the cæcum into the ileum and thus into the colon below the growth.

Summer speaks well of this method, but he suggests an improvement. The ileum not being divided but "approximated to the sigmoid, and two anastomotic openings made between these openings, the ileum should be occluded by a purse-string suture, and both limbs fastened to the sigmoid so as to close any opening that might permit a loop of intestine becoming strangulated." I have not tried this plan, but I should be afraid that either leakage or infection might occur at the site of the ligature (*vide* Fig. 159). Neither unilateral exclusion nor entero-anastomosis is sufficient to prevent leakage from a fistula in the small intestine, and it is better as a rule to resect than to perform bilateral

exclusion in these cases. In some cases, however, it may be easier and safer to perform bilateral exclusion especially for entero-vaginal fistula. Lance (*Thèse de Paris*, 1903, No. 348; quoted by Moynihan, *Lancet*, vol. ii. 1904, p. 1012) has collected the records of 76 cases of bilateral exclusion performed upon the human subject. In eight of these the operation was undertaken for the treatment of fæcal fistula following operation for strangulated hernia. All the patients recovered, but in three of them the fistulous loop was afterwards excised. The remaining exclusions were for growth, chronic intussusception, tuberculosis of the large intestine, entero-vaginal fistula, &c. "In no case was there any ill effect attributable directly to the method." As a rule when a fistula from the excluded loop was not already present the



two ends of the intestine were brought to the skin and sutured there. This procedure is sometimes known as "Hochenegg's method" of exclusion. The pre-existing fistulae closed "in all the cases except those in which malignant disease was present. As a rule only one end of the loop remained permanently open, the other gradually dwindling in size, and eventually becoming quite closed" (Moynihan).

CLOSURE OF FÆCAL FISTULA OR ARTIFICIAL ANUS.

Fig. 160 shows, diagrammatically, some of the chief points of difference between a fæcal fistula and an artificial anus. Before operating, certain points of much practical importance should be considered, and first how far any spur or septum is developed. The more marked this is, the less is the chance of closing the opening by any slight plastic operation such as paring and suturing the edges of the opening. The spur being left behind, the fæces will make their way through the sutures, and the longer this condition is allowed to remain, the more, of necessity, will the lower segment of intestine atrophy, and the more

marked will be the difference between the two parts of the bowel. Other important points are the nutrition of the patient and the condition of the area surrounding the wound. The higher the fistula is situated in the small intestine the more will the nutrition have suffered, and the more urgent will be the need for an early operation for closing the fistula. The more profuse and liquid is the discharge and the higher the leak, the more infiltrated will be the eczematous area around.

Previous Treatment.—Small fæcal fistulæ often close spontaneously, others may be easily closed by inversion within a few days of their formation for temporarily draining distended intestine in intestinal obstruction or peritonitis; this can be done under cocaine anæsthesia if performed early before dense adhesions have formed, and the parietal wound has contracted.

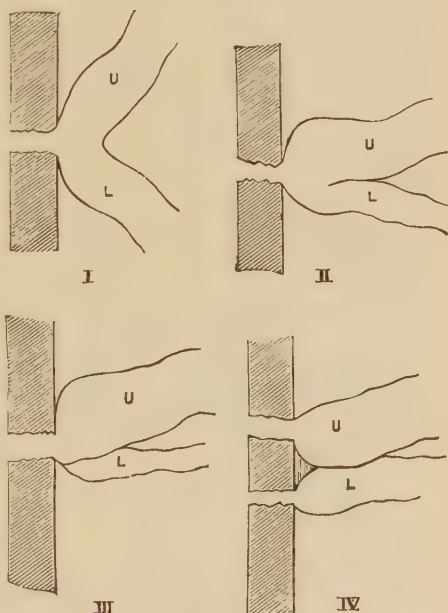
Formerly the cautery was used for narrow fistulæ, but this method is not to be recommended in preference to more certain and less painful methods; extra-peritonæal inversion can generally be performed in these cases without risk to the patient, but this method often fails, because the tissues sutured are not healthy, and particularly because of the absence of the serous coat and the adhesive lymph derived from it; none of the other coats adhere so well and so quickly.

The pressure of a truss is very rarely successful and is painful. The destruction of the spur may be effected by means of Mr. Paul's enterotome which exerts elastic or spring pressure upon the spur, which is held between the jaws of the enterotome. The pressure can be gradually increased by means of a screw. The instrument bites through and safely destroys most of the spur in three or four days.

A somewhat similar instrument may be used to make a communication through the base of the spur when the two pieces of bowel are in contact for some distance from the apertures; this makes the subsequent operation for closing the fistula much easier, and may render a resection unnecessary in some cases.

Sir W. M. Banks (*Clin. Notes*, p. 94) describes the following simple and ingenious method. Where the septum or spur is not well developed,

FIG. 160.



U, Upper. L, Lower bowel. I, Fæcal fistula. The gut is not bent very acutely on itself, and there is no spur. The opening in the bowel is usually small and communicates with the skin generally by a sinus-like track. II., III., Artificial anus. The bowel is here more acutely bent and a spur is present. In an artificial anus the opening communicates more directly with the surface than is here shown. IV., Double fæcal fistula. (Greig Smith.)

it may be expected to succeed. In an artificial anus in the groin, after a femoral hernia, he introduced a thick piece of india-rubber tubing, pushing one end up the ascending and the other down the descending bowel. It was secured by silk brought out of the opening. It was calculated that the pressure of the tubing against the projecting spur would press it back, and allow the fæces to pass round the corner without passing out of the artificial anus. At the end of seven weeks nearly all the fæces passed by the rectum instead of by the artificial

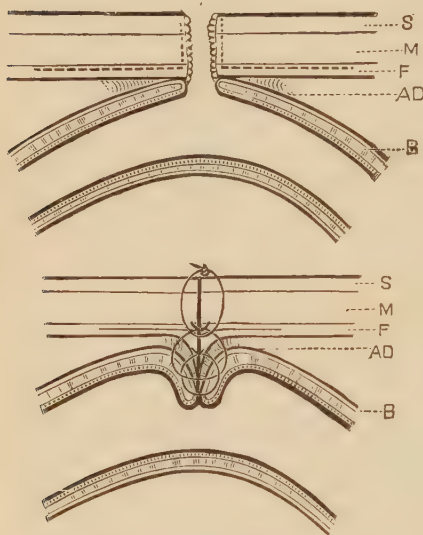
anus, this being reduced to a sinus, giving vent to a few drops of yellowish fluid. At the end of three months this completely closed. This is a tedious process, which is only suitable for a few cases. In fistulæ with considerable spur formation and artificial anus in the small intestine it is usually imperative to operate without delay to prevent wasting; and resection of all the diseased part, with end to end union of the intestine above and below, is the most certain and satisfactory way of attaining this end, although other methods may seem safer at first sight.

Operation.

Three methods will be mentioned. i. Here the peritonæal sac is not opened. The margins of the fistula having been sufficiently freed, they are pared and brought together with cat-gut and silk sutures and kept apposed (*vide* Figs. 161 and 162). This method can only be suitable to small fæcal fistulæ where the exposure of mucous membrane is trifling and no spur is present. It usually fails from the separation of the edges of the fistula not being free enough, owing to the operator's

FIG. 161.

G Ft



Diagrams to show Greig Smith's method of closing fæcal fistula.

Fi, Fistula in abdominal wall communicating with the bowel. G, Granulations lining the fæcal fistula. S, Skin. M, Muscular layer. F, Sub-peritonæal tissue. AD, Adhesions between bowel and peritonæum surrounding the fistula. B, Bowel.

The broken line in the upper diagram shows the incisions around the fistula and in the sub-peritonæal areolar tissue. The lower diagram shows the operation completed and the sutures placed. (Greig Smith.)

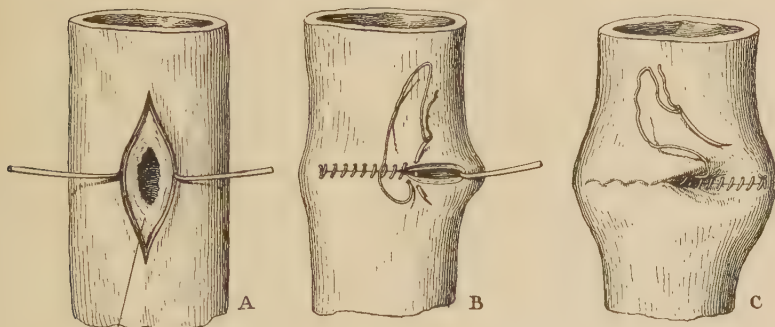
fear of opening the peritonæalsac, thus causing tension on the sutures (*vide* p. 415).

The late Mr. Greig Smith (*Abdom. Surg.*, p. 728) spoke highly of the following operation, which may be used both for cases of fæcal fistula and artificial anus. In applying the method, however, to cases of artificial anus, the spur must be first diminished and the lower part of the bowel dilated to some extent. In order to accomplish this, Mr. Greig Smith advises the introduction of an india-rubber tube, after Banks' plan, for some days before the operation is performed. A brisk

purge should be given early on the preceding day to empty the intestines above the fistula, and the bowel below should be cleared of scybala by means of an injection of soap and water either by the anus or through the artificial anus if practicable. No food should be given by the mouth for twelve hours before the operation, and only small quantities of fluid for several days after it.

Any granulations having been scraped away and the aperture in the bowel plugged by a sponge, two incisions are made, one above and one below the fistula, and joined by curved incisions which include the fistula. The extra-peritonæal fatty tissue having been reached, the parietal peritonæum is separated from the abdominal wall all round the fistula for at least two inches. This step will be best carried out by commencing the separation at the extremities of the incisions which are most remote from the fistula, and working towards the latter.

FIG. 162.



Part of bowel to be removed.

Excision of fæcal fistula and enteroplasty.

A, All the inflamed tissues around the opening are removed, an elliptical or oval incision being made along the intestine. B, The longitudinal wound is retracted and converted into a transverse one. The deep stitch which pierces all the coats is being inserted. C, Inversion by means of Cushing's suture.

The bowel with the loosened peritonæum can now be lifted out through the incision in the parietes. If there is any difficulty in doing this, a little more detachment of peritonæum will make it easy. The fistulous track is now cut away down to the level of the bowel, and the opening in the latter closed by one or more rows of Lembert's sutures inverting the raw edges (Fig. 161). The line of suture must be transverse to the axis of the bowel, so that the lumen of the latter may not be narrowed. This is especially important when the opening is a large one (*vide* Fig. 162). The intestine and peritonæum are now replaced and the parietal incision closed, with the exception of a small opening through which a drain is passed down to the sutured gut. This method may fail on account of want of removal of unhealthy tissues and the absence of the normal peritonæal covering of the bowel. The subperitonæal fat and the external surface of the parietal peritonæum are very poor substitutes, which do not unite nearly so readily and securely as the visceral peritonæum. Narrowing of the lumen either

from kinking, pre-existing spur, or improper inversion, may also defeat the object of the operation.

ii. and iii. Here the peritonæal sac is opened.

ii. Closure of the opening without complete resection of the bowel.—The preliminary steps as to diet and treatment of the eczematous skin given below (p. 419) should be carefully attended to. The following account is taken from the report of a patient under my care in Guy's Hospital in August, 1895:—

At an operation for acute intestinal obstruction due to bands, a gangrenous patch had been found in the ileum, and the intestine had been drained through a Paul's glass tube. This the patient pulled out, and an artificial anus resulted. The gut was plugged with small sponges tied on silk and pushed about two inches above and below the opening. Two curved incisions were then made so as to include an oval three inches and a half long and an inch and a half wide. In the centre of this lay the opening surrounded by the usual eczematous margin, most of which was enclosed by the above incisions. The incisions passed through the rectus on each side. After the posterior layers of the sheath had been reached the incisions were very cautiously deepened until the peritonæum was reached. In opening this an exploring finger was introduced through each lateral cut so as to make certain that no coils of intestine were adherent beneath. The finger being used as a director, the peritonæum was cut through along the lateral incisions in their whole extent. An oval island of the tissue forming the abdominal wall was now set free, and could be drawn forward with the bowel adherent to it below, and showing the sponges which had been introduced as plugs bulging out its coats. The bowel in which lay the artificial anus was now separated from adjacent coils, and the adhesions which bound it to the parietes, partly with a steel director, partly with blunt-pointed scissors, used at one time closed and at another open. Sponges and iodoform tampons had previously been packed around so as to soak up any blood. When the artificial anus had been separated from all adhesions it was found to be about two inches and a half long. Its edges were pared, and the plugging sponges having been removed, the opening was closed with a double silk suture—first a continuous one taking up all the coats, and then a row of Lembert's securing sufficient inversion. These were carried well beyond the actual limits of the opening (Fig. 99, p. 353). A little iodoform having been rubbed in along the line of suture, the intestine was returned. A few tags of omentum which were adherent to the abdominal wall in the vicinity of the wound were detached and tied. When the intestine was returned the interior of the abdomen was quite free from all blood or other discharges. The edges of the wound were then brought together as far as possible, but this was only feasible above and below. In the centre was a lozenge-shaped gap, measuring two inches and a half long by an inch wide, at the bottom of which lay the sutured intestine. The gap was lightly plugged with iodoform gauze wrung out of carbolic acid lotion (1 in 20). The patient made a good recovery, the only drawback being his weak condition, due to his having been fed so long (seventy-two hours, including the time before and after the operation) by enemata. Flatus was passed on the second day, and the bowels acted well two days later. A fortnight after the operation I placed numerous large grafts, cut from the shoulders by Thiersch's method, on the granulating surface which represented the remains of the oval gap in the parietes. All was soundly healed within five weeks of the operation. I lost sight of the patient for five months, when he returned with a ventral hernia. This he attributed to his having had scarlet fever, and to the pad of the belt with which he had been supplied having shrunk after the baking to which it and his clothing had been submitted. He was otherwise in excellent health, without any flatulence or constipation, enjoying his food and able to go about helping his father, who is a costermonger. He was supplied with a new pad. If the hernia increase, it will, I think, be now possible to pare the edges of the old oval gap, and to bring them together, a step quite impossible at the time of the operation.

For a consideration of the methods of treating ventral hernia by overlapping and by the introduction of wire filigree, the reader is referred to p. 103, Figs. 43 to 50.

iii. **Closure of the Artificial Anus with complete resection of the bowel.**—If this step be needed I know of no clearer account than that of Mr. Makins (*St. Thomas's Hosp. Rep.*, vol. xiii. p. 18). The skill with which the operation was carried out was only equalled by the thoughtfulness with which it was planned.

The patient was 21. The artificial anus, dating to a hernia, was high up in the small intestine, and opened about an inch and a half above the centre of Poupart's ligament. Here, at the bottom of a small pit, the mucous membrane of the intestine was slightly prolapsed. The gut was firmly attached: the finger only passed into the upper opening; the lower could not be found. First, the usual eczematous condition was very much improved by the use of a small shield, and mopping away of discharge with absorbent wool. No food was given by the mouth after the evening of the second day before the operation, nutrient enemata being given every four hours. During the day before, the upper end of the bowel was washed out with injections of salicylic lotion. As bile-stained fluid was escaping from the fistula an hour before the operation, this washing out was repeated. Before beginning the operation a bit of carbolised sponge attached to string was passed for two inches into the upper end of the bowel. A vertical incision of two inches and a half being made through the abdominal wall, the upper end of the intestine, normal in size, was dissected free from its adhesions; the lower end, lying just below it, was contracted to the size of a pencil, with an opening only large enough to admit a director.*

The two ends of the gut being now provisionally clamped with forceps (Fig. 137), sheathed in tubing, they were drawn out, and a number of sponges attached to string packed round them. The sponge was then drawn from the upper end of the intestine and about an inch removed from the upper end and two inches and a half from the lower one, together with a wedge of mesentery four inches long by three-quarters of an inch wide.† The cut surfaces then nearly corresponded. The bleeding points having been tied in the mesentery, this was united with six silk sutures, and the gut then sutured as follows:—A first row of twenty-five very fine Chinese-twist stitches were passed with a small curved needle through the whole thickness of the gut, about one-tenth of an inch from its free margin, commencing at the mesenteric border. These were tied in batches of five at a time. Then a second row of Lembert's sutures (Figs. 99 and 353) were passed and tied in the same manner. During the stitching, which took about three-quarters of an hour, the gut was kept moist with warm salicylic lotion. After the bowel was closed and returned, it was found impossible to close the whole wound. As this could only be brought together above and below, the granulations were shaved away and the intestine left at the bottom of a deep pit. Iodoform-gauze and pine-wood dressings were applied. The patient made a good recovery. Two days later the intestine could be seen at the bottom of the wound covered with lymph and showing vermicular movements. The bowels acted naturally two days after the operation. No fæces came by the wound, but twelve sutures were thus discharged.

It is easier and much better to use continuous sutures, and catgut is better than silk for the deep suture which pieces all the coats. Catgut, being absorbable, leads to less sloughing, less risk of leakage, and earlier healing of the mucosa. Silk may remain partly attached for some time, and thus it keeps up ulceration. Resection and end to end union are fully described at pp. 384, 393.

In certain cases the methods already given may not be applicable or suitable, and in these short circuiting or exclusion (*vide* pp. 402, 414,

* Over two months had elapsed since the formation of the fistula, and one month since the last proper action of the bowels.

† It is simpler not to excise a wedge of mesentery, but to tie it in sections to the bowel, and before dividing either this or the near mesentery.

Figs. 155—159) may be safer, although they are less satisfactory than the direct treatment of the fistula as a rule.

In a case of gangrenous strangulated cæcal umbilical hernia in a very stout old lady, one of us (R. P. R.) had to resect the cæcum and three feet of the ileum. After emptying the intestine as well as possible, end to end union of the equal ends of the ileum and ascending colon was adopted. A fistula followed, owing partly to the gangrenous condition of the abdominal wall. A month later it was clear that no local interference was likely to be successful; therefore a gum elastic catheter was passed into the ileum, and ileo-sigmoidostomy performed through a left lateral incision well away from the fistula. The catheter was very useful as a guide to the lower part of the small intestine. The fistulous end of the ileum was then inverted. The patient died about twelve hours later from cardiac failure.

Another case of anastomosis of the lower part of the ileum to the transverse colon, with inversion of the fistulous ends of ileum and colon, proved more successful. This operation was undertaken to close the artificial anus left after an extensive resection for growth.

Tuberculous disease, especially of the ileo-cæcal region, may be too extensive for resection to be contemplated, and the patient's condition may be too grave to allow such a severe operation; unilateral or bilateral exclusion may then be resorted to, and may give much, if not complete, relief.* Duodenal fistula may be treated by posterior gastro-jejunostomy, with occlusion of the pylorus, by a temporary jejunostomy, or by inversion or resection, which may be a very difficult and severe operation for the marasmic subjects of this high fistula; fistulæ between the small intestine and the vagina may be treated by bilateral exclusion in some cases.

ENTEROPLASTY.

This term has been given to an operation for the relief (short of resection) of strictures of the intestine believed to be innocent. It is based upon a similar operation which has been successfully performed upon the constricted pylorus and the first part of the duodenum following upon simple ulceration (*vide* Fig. 162).

Innocent intestinal strictures are very rare, but they may arise from contraction of tuberculous ulcers of the small or large intestine, or they may follow dysenteric ulceration of the latter. Sargent (*Ann. of Surg.*, 1904, vol. xxxix. p. 733) has related three cases of stricture of the small intestine following strangulated hernia. Mr. Sargent also presented a table of 18 collected cases, including his own. In six of these there were two strictures, and most of the single strictures were extensive and not annular. In six no operation was performed; in two enteroplasty was performed successfully, one by Mollard and Bernay and the other by Abbott.

Primary resection was successful in three cases, and secondary resection after a preliminary enterostomy succeeded in another case (Alexis Thomson). Enterostomy failed to save three late cases. Lateral anastomosis was successful in one case. One patient died of peritonitis, although the anastomosis did not leak.

The late Mr. H. W. Allingham's two cases of enteroplasty were

* Mr. Roughton (*Lancet*, 1902, vol. ii. p. 1128) showed a man, before the Harveian Society, in whom he had anastomosed the ileum to the ascending colon for tuberculous fistula of the cæcum. No faecal discharge came through the fistula, which remained open.

the first to be published (*Lancet*, vol. i. 1894, p. 1550). One such stricture occurred in a woman, aged 48, at the junction of the ileum and jejunum, the other in the sigmoid of a patient aged 73. It is simply stated that "the stricture was innocent," and "not malignant." As the cases were published within two months of the operation, the nature of the stricture must remain very doubtful. The age of the last patient, the site of the stricture in the sigmoid, and the absence of any history of dysentery are very suspicious, although there are several specimens of innocent stricture of the colon in the Guy's Hospital museum, careful microscopical examination having failed to discover any sign of carcinoma. Some of these are undoubtedly tuberculous. In each case the stricture was divided in the following way: The bowel having been drawn out, shut off with sponges, and clamps applied above and below, the bowel and stricture were divided longitudinally for three inches on the side of the gut opposite to the mesenteric attachment. Each lip of the longitudinal incision was then caught hold of at about its centre, pulled apart so that at first it gave the appearance of a diamond-shaped opening, and then, by further pulling in the same direction, the original longitudinal incision was made into one transverse to the long axis of the bowel. The opening was then closed, first with a continuous suture uniting the mucous membrane, and then by Lembert's interrupted sutures. It is better to make the deep stitch pierce all the coats, and thus to secure a firmer hold, as well as avoid the risk of eversion of the mucous membrane. In any case of stricture of the large intestine, unless there is some very strong evidence in favour of its innocency, it is safer to excise it, for the chances in favour of the presence of carcinoma are enormous.

In many cases of stricture of the small intestine, enteroplasty, however ideal it may seem, may not be suitable on account of the existence of multiple strictures, or extensive ones. Moreover, active ulceration at the site of the stricture is very common, and this may persist and lead to re-formation of the stricture. It should also be born in mind that carcinoma does occasionally occur in the small intestine, and even in comparatively young people. In other cases of acute following upon chronic obstruction, the bowel may be so damaged, that enteroplasty is out of the question, and resection or enterostomy has to be adopted.

Sargent draws attention to the risk of spur formation at the mesenteric attachment in performing enteroplasty. In some cases lateral anastomosis undoubtedly offers a better prospect, although for a narrow healed annular stricture of the small intestine enteroplasty is the simplest and safest operation.

CHAPTER VI.

OPERATIVE INTERFERENCE IN GUNSHOT AND OTHER INJURIES OF THE ABDOMEN. RUPTURE OF THE INTESTINE.

GUNSHOT AND OTHER INJURIES.

WE owe the great advances lately made here, in the first place, to antiseptic surgery, and, in the second, to the zeal with which American surgeons have taken up the matter and made known their results, unsuccessful as well as successful.

The South African and Japanese wars have greatly altered our views upon military abdominal surgery, both by increasing our knowledge of the effects of modern projectiles, and also by making us realise the dreadful difficulties which make it impracticable to treat military wounds radically and without delay. In civil life it is quite different, for it is generally possible to operate under good conditions within a few hours of the catastrophe.

1. *Examination of the Wound with regard to Penetration.*—Blackening of the wound and the clothes with powder suggests a close shot and probable penetration.

A. B. Johnson's experiments (*Ann. of Surg.*, vol. xxxix. 1904, p. 798) have shown that the powder marks which are produced upon the skin and clothes by smokeless powder are much less distinct and definite than those caused by black powder. With Mauser and Colt pistols loaded with smokeless powder, and fired at a distance of more than one foot, no marks are formed upon the naked skin, and only very faint ones at a distance of three inches. Edges clean cut and equally stained show that the bullet has struck perpendicularly. Unequal staining and raggedness suggest obliquity of impact; and the less perpendicular this is, the less the probability of penetration. If there exists a continuous track of tenderness, especially if accompanied with slight redness, from the wound for some distance over the abdominal surface, it is fair to infer that the missile has wormed itself between the layers without penetration (Parkes).

Symptoms indicating Penetration and Injury of the Viscera.

(i) *There may be none at all at first*, but symptoms of hæmorrhage or of early peritonitis may soon appear. Dr. Malcolm Harris* has very properly laid great stress upon this fact, and rightly advocates early exploration without waiting for signs of these grave conditions to develop. In civil practice this is generally possible, but it is nearly

* *Ann. of Surg.*, 1904, vol. xxxix., p. 356.

always impracticable and very dangerous under the circumstances of war. (ii) Escape of fæces, bile, or urine from the wound is, of course, diagnostic of penetration, but rare. (iii) Repeated hæmatemesis indicates penetration and injury to the stomach or small intestine high up. It may, however, be due to contusion. (iv) Profuse hæmorrhage per anum points to penetration and injury of intestine, but is seldom seen sufficiently early to be of value. (v) Hæmaturia indicates injury of some part of the urinary tract. (vi) Escape of blood from the wound, if too profuse to be accounted for by a wound of a vessel in the abdominal wall, points to penetration and visceral injury. (vii) Shock. This does not go for much unless hæmorrhage is clearly present also, owing to the great difference in individual peculiarities.

Dr. Crile has shown that shock varies very much with the situation of the internal injuries, those involving the diaphragm or the stomach being attended with far more depression than those involving the pelvic or lower abdominal viscera.

(viii) Pain, tenderness, and rigidity are the earliest and the most reliable signs of peritonæal irritation, and when all three are associated together, it is almost certain that perforation of one of the viscera has occurred.

Vomiting is an uncertain symptom, and its absence is therefore not to be relied upon. Rapidly vanishing liver dulness with the abdomen still flat may indicate penetration and the escape of gas from the stomach or intestine, but, if delayed, the tympanites may be due to paralysis of the intestines from shock or peritonitis.

(ix) Circumscribed dulness, and rarely bulging near the wound or into the rectum or vagina, may indicate bleeding from a large vessel and accumulation of blood in the peritonæum, and probable visceral injury, but, to be of value, these signs must come on within a few hours. Free fluid may be indicated by shifting dulness in the flanks, but blood generally clots, and the dulness may not move upon changing the position of the patient. The signs of severe internal hæmorrhage are well known, but stress may be laid upon the following: rapid small pulse, shallow sighing respiration, restlessness, pallor and shrinking of the features, dilated pupils, cold clammy skin, tinnitus aurium, dimness of vision, and delirium. The more gradual the hæmorrhage, the less will these signs and symptoms be noticed until a sudden collapse occurs. A diminishing count of red corpuscles is a sign of bleeding that may help in some cases. It is simply waste of time to endeavour to demonstrate the existence of perforation of the intestines by rectal insufflation of gas or air, and the same may be said of Connell's method of injection of saline solution into the peritonæal cavity through the wound, and the examination of some of the fluid later for fæces, &c. The symptoms of peritonitis come on sooner or later, and when they are well developed, an operation offers but a forlorn hope.

Paralysis of any part below the level of the wound is a most grave complication, indicating, as it does, injury to cord or nerves, as well as, probably, to viscera.

Other points will be the size of the bullet and the amount of fulminative or powder, the distance and direction in which the firearm was held. A single opening gives, *per se*, a faint hope that there is no penetration.

In cases of doubt as to penetration, the wound will be first enlarged, and the line of damage to the tissues carefully followed up, any exploring instruments being kept strictly aseptic.

Probable Amount of Damage.—Dr. Parkes (*Ann. of Surg.*, November, 1887) gives the following suggestions:—"An antero-posterior shot below the level of the umbilicus and well towards the lateral surfaces of the body will be very likely to miss the small intestines entirely, and expend its damage on the large bowel. The same kind of wound high in the lateral surfaces may pass into or through the liver without injuring the intestines, or the spleen alone if the entrance is on the left side.

"If the wound is so situated that the bullet enters the abdomen through the diaphragm, adding injury of abdominal viscera to that of the contents of the chest, the surgeon's help will probably be of little use. A wound of entrance and exit, or an entrance wound alone, showing passage of the ball from side to side through the abdomen, means the worst of injuries, and suggests the need of the greatest care in staying of hæmorrhage, repair of intestines, and toilet of the contents.

"Antero-posterior perforation, if complete, can only fail to wound the small intestines when situated well on the outskirts of the surface of the abdomen; seemingly there can be no exception to this proposition, save in those extremely rare instances in which the perforating body traverses the cavity without injuring the contents.*

"Penetration through the posterior walls of the cavity, if complete, with likelihood of laceration of important fixed organs, argues an injury of the most severe character, one in which the surgeon's aid will be of no avail in the majority of cases. The exceptions in which the severity will not prove insurmountable will be transit through the space between the lower end of the kidney and the crest of the ilium, and in wounds occupying the outskirts of the entire posterior surface. . . . Many instances are recorded of recovery from posterior penetration of the large and fixed viscera of the abdomen without any surgical operation."

Mr. Makins (*Surgical Experiences in South Africa*, 1901, chap. xi.) agrees with most of these conclusions, and adds that wounds passing directly backwards from the iliac regions were very unfavourable on account of the liability of injury of the iliac vessels. Vertical wounds implicating the diaphragm and abdomen or abdomen and pelvis were not very unfavourable. Penetrations from the buttocks to below the umbilicus often did well, and perforations of the pelvic viscera were comparatively favourable.

"Explosive" wounds due to large leaden bullets of the Martini-Henry or "Express" type were very serious. Watson Cheyne (*Brit. Med. Journ.*, May 12, 1900) recorded a remarkable case in which a spent bullet ruptured the intestine in two places without piercing the skin of the abdomen.

* With modern bullets it is by no means uncommon for the projectile to traverse the peritonæal cavity without leading to any symptoms or signs of perforation of the hollow viscera.

Question of the Advisability of Operative Interference.—A. In Civil Practice.—If a capable and experienced surgeon is available an exploration should be undertaken at the earliest possible moment in order to anticipate the onset of peritonitis, and to prevent any avoidable increase of internal hæmorrhage.

For these reasons it is not even wise to wait and hope that any shock which may be present may pass off; but it is better to combat this by infusion and injection of ergot, adrenalin, or strychnine during the operation, after the bleeding points have been secured.

When grave doubt exists as to the existence of penetration, it is imperative to settle the question by exploration, for it is far better for a careful and aseptic surgeon to perform an occasional blank exploration than to neglect an early perforation of the bowel until symptoms of peritonitis supervene, and the chance of a successful operation has greatly diminished. By operating early astonishing recoveries occur from most extensive visceral injuries and peritonæal extravasations.

Dr. Harris (*loc. cit.*) records sixteen consecutive operations for penetrating gunshot and other wounds of the abdomen, with thirteen recoveries. In all but one of these cases the operation was performed within three hours of the accident. One patient died upon the operating table from profuse hæmorrhage, the source of which could not be discovered and controlled in time to save the man's life. Another man suffered severely from shock and injuries of both lungs, as well as hæmorrhage into the spinal canal. The remaining death was due to peritonitis, although the operation was performed within an hour of the shooting; the eight perforations of the small intestine, sigmoid, and transverse colon had been well closed. In one case, there was no visceral injury, but only hæmorrhage from a large artery in the great omentum just below the stomach. There were two blank explorations, but the bullet was found and removed in each case, and both patients recovered. "But, excluding these cases, we still have 11 cases with perforation and hæmorrhage in which operation was absolutely indicated, with but one death. Instead of the usual mortality rate of 60 per cent. to 70 per cent. following operation, we have over 90 per cent. recoveries." Dr. Harris gives two reasons for his good results: the adoption of immediate operation and drainage when the gastro-intestinal tract has been opened.

Fenner (*Ann. of Surg.*, January, 1902) records six successful operations for penetrating wounds of the abdomen. One patient recovered although there were multiple perforations of the ileum; another got well in spite of wounds of the diaphragm, stomach, liver, and pleura, with pneumothorax and pneumonia later.

Dr. Fenner also published notes of 152 operations which were performed in hospital practice between 1892 and 1901. There were 87 deaths, a mortality of 37.2 per cent.; 113 of the operations were for gunshot injuries, with 78 deaths, a mortality of 69 per cent. The remaining 39 were for stab wounds, with 9 deaths, a mortality of only 23 per cent.

Because it is impossible to tell from the general symptoms and external appearances whether visceral injuries have occurred, Fenner advocates early exploration, and a systematic examination of all the intestine and other abdominal viscera.

Möhr (*Arch. für Klin. Chir.*, vol. lxxiii., Nos. 1 and 2) records forty-eight operations which were performed within four and five hours of the shooting. The mortality in these cases was only 14.5 per cent., which he estimates to be less than a third of the ordinary death-rate.

R. W. Johnson, of Baltimore (*New York Med. Journ.*, March 26, 1904) records five successful operations for penetrating wounds of the abdomen. One patient had seventeen perforations of the small intestine, and eleven rents of the mesentery; fecal extravasation had occurred in enormous quantities, but the patient was discharged well on the twenty-first day. Amyx (*Med. Rec.*, Sept. 20, 1902) records a recovery after nineteen perforations of the small intestine, cæcum, colon, and sigmoid flexure and four lacerations of the mesentery. Resection of eleven inches of small intestine was necessary, and an anastomosis made with a Murphy button. The remaining seven perforations were sutured. Operation commenced two hours after the shooting and lasted three hours. A gluteal abscess had to be opened later, and the bullet was found and removed.

Brown (*New York Med. and Surg. Journ.*, April 16, 1904) publishes nine recent operations, with three deaths, one from shock and two from peritonitis which existed at the time of the operations.

Occasionally a late operation may succeed, although recovery is rarely to be expected after twenty-four hours. Pettus (*New York Med. Journ.*, Aug. 30, 1902) records the case of a patient who recovered although the operation was delayed for thirty-one hours, and seven perforations of the small intestine had to be sutured. Irrigation and drainage were employed.

Prof. Nancrede (*Ann. of Surg.*, June, 1887, p. 474) thus states the advantages of an operation:—"We can either forestall septic peritonitis or reduce its dangers to a minimum; we can prevent sapremia—a common cause of death, as I believe. . . . Should peritonitis have set in, we can afford sufficient drainage for the effusions, which may in themselves be already poisonous, or, as we have shown, will assuredly become the chief cause of danger; we can substitute for adhesions of doubtful permanency certain methods which secure the escape of the injured portions of gut into the lumen of the bowel; we can prevent the fatal results which must follow the casting off of a decomposing slough of a wounded portion of omentum or mesentery into the general peritoneal cavity; we can arrest hæmorrhage, which from its amount will prove fatal, or from decomposition will equally produce lethal results; we can restore the continuity of the gut, if it be nearly or completely severed, the former condition being not uncommon; we can avoid the risk of fecal fistula; . . . and we can remove a hopelessly damaged kidney or spleen, and repair a wounded pancreas or liver."*

With regard to the presence of peritonitis, the late Mr. Greig Smith wrote (*loc. supra cit.*, p. 704): "Undoubted and severe peritonitis existing on the second and third day, is by most authorities recognised as a contra-indication. In such cases it is improbable that the sites of perforation could be found; and, if they were, that they could be dealt with without the production of excessive traumatism. There is little use in cleansing the cavity if it is to be at once refilled, and there is little use in looking for the perforations if they can neither be closed

* It is rare to have to remove either the kidney or the spleen in modern military practice, for the wounds which the Mauser and similar bullets inflict are usually quite small, so that packing or suture generally serve to arrest the hæmorrhage. Similar perforations of the liver also recover spontaneously in many cases. With sporting bullets and shell wounds things are very different.

nor fixed in the wound, while there is positive danger in adding to the risk from traumatism. In such cases the most that can be done is to make a small parietal opening with the help of local anæsthesia, and permit the discharge of the noxious fluids, giving the patient the benefit of the remote chance of spontaneous cure with intestinal fistula."

It is no doubt still true that when well-marked symptoms of peritonitis have appeared surgical intervention is almost hopeless, but occasionally marvellous recoveries occur, and therefore it is well to let the pus out and drain in every case. In late cases, this is all that can be done without doing more harm than good in the desperate condition of the patient. The lesions produced by the rude implements of civil life are far more serious and extensive than those due to the modern military bullet of small calibre and high velocity.

B. In Military Practice.—Our views upon military surgery have been greatly modified by the knowledge derived from the effects of modern projectiles used in the South African and Japanese wars, and also from a fuller appreciation of the difficulties which make it impossible to treat military wounds in the same radical way that is generally possible and imperative in civil life.

Up to the time of the Boer war these wounds were considered to be almost necessarily fatal if an abdominal section were not immediately performed, death resulting usually from hæmorrhage or from septic peritonitis.

The results of abdominal wounds made by the Mauser bullet have, however, produced practically a revolution as regards the question now under consideration. For it has been found that these injuries, when not immediately fatal, have been attended with far better results under expectant than operative treatment, because of the great dangers of operating under the very unfavourable conditions which are inseparable from war. Mr. Makins (*loc. cit.*) divides these difficulties into administrative and surgical.

(a) *Administrative.*—The surgical staff of a field hospital is better employed in attending to more hopeful cases; and the number of assistants required at a laparotomy cannot be spared at the time when that operation would be hopeful.

(b) *Surgical.*—The diagnosis of a perforating lesion is difficult, an exploration being the only sure way. The difficulties of temperature, of wind and dust, and of getting a sufficient amount of water are very great. Moreover, it is almost impossible to provide the rest and attention which are required in the after-treatment of these cases.

It is not surprising, therefore, that early explorations are not attended with great success, and that surgeons have wisely limited their number to a minimum.

Major Mallins (*Report on Surgical Cases noted in the South African War*, Surgeon-General Stevenson, 1905) records 207 cases of penetrating wounds of the abdomen, of which 143 recovered; in 40 per cent. of these it was impossible to diagnose a visceral lesion, as symptoms were absent. Twenty-six laparotomies were performed, with only eight recoveries. Most of the operations were performed after the development of peritonitis, so that a mortality of 69·2 per cent. is not surprising.

La Garde (*Med. News*, Nov. 15, 1902) mentions that in the Surgeon-General's report for 1900 116 operations for penetrating wounds of the abdomen are recorded, with a mortality of 70 per cent; the large majority of those that recovered had no intestinal injury.

I will quote some of Mr. Makins' instructive conclusions upon this subject (*loc. supra cit.*).

"(1) Wounds in the intestinal area should be watched with care. In face of the numerous spontaneous recoveries in such cases, habitual abdominal exploration is not justified under the conditions usually prevailing in the field.

"(2) The very large number excluded by this rule from operation leads us to a smaller and less satisfactory number to be divided into two categories. (a) Patients who die within the first twelve hours. Some of these patients are hopeless from the first; a few might be saved by an operation under more favourable circumstances. (b) Patients with very severe injuries, as evidenced by the escape of fæces, or with wounds from flank to flank or taking an antero-posterior course in the abdominal area. These patients die, and the majority of them will always die whether operated on or not. The undertaking of operations on them is unpleasant to the surgeon, as being unlikely to be attended with any great degree of success, whence the impression may gain ground that patients are killed by the operation. None the less I think these operations ought to be undertaken when the attendant conditions allow, and it is from this class that the real successes will be drawn in the future.

"The history of such injuries after all corresponds exactly with what we were long familiar with in traumatic ruptures in civil practice, and now know may be avoided by sufficiently early interference. The whole question here is one of time, and this will always be the trouble in military work."

"(3) The expectant attitude which is obligatory under the above rules, in doubtful cases, brings us face to face with a large proportion of patients in the early or late stage of peritoneal septicæmia. These cases run on exactly the same lines as those in which the same condition is secondary to spontaneous rupture of the bowel, in which we consider it our duty to operate and in which a definite percentage of recoveries is obtained. Hence another unpleasant duty is here imposed upon the surgeon. . . .

"(4) The treatment of the cases in which an expectant attitude is followed by the advent of localised suppuration presents no difficulty. Simple incision alone is needed, and healing follows. As a rule this is a late condition.

"(5) Cases of injury to the colon, in which the posterior aspect is involved, should be treated by free opening up of the wound, and either by suture of the bowel or else its fixation to the surface."

"Under really satisfactory conditions nothing that I saw in my South African experience, would lead me to recommend any deviation from the ordinary rules of modern surgery, except in so far as I should be more readily inclined to believe that wounds in certain positions, already indicated, might occur without perforation of the bowel when produced by small calibre bullets; and further, in cases where I believed the fixed portion of the large bowel was the segment of the

alimentary canal that had been exposed to risk, I should not be inclined to operate hastily."

"A careful consideration of the whole of the cases that I saw leaves me with the firm impression that perforating wounds of the small intestine differ in no way in their results and consequences when produced by small calibre bullets from those of every day experience, although when there is reason merely to suspect their presence an exploration is not indicated under circumstances that may add fresh danger to the patient."

Sir F. Treves (*Brit. Med. Journ.*, vol. i. 1901, p. 1156) mentions cases in which the abdomen was completely traversed in various directions, and yet, in spite of prolonged exposure and tedious transport, recovery took place with only very slight symptoms. In the earlier part of the war he describes undertaking several abdominal sections, but he found that he was doing more harm than good, as the coils of intestine already adhered and sealed the wounds, there being no prolapse of mucous membrane or escape of intestinal contents. Treves concludes that it is impossible to operate successfully in cases in which the abdomen is traversed above the umbilicus, owing to the multiple character of the injuries; whilst the cases in which the abdomen is traversed below the umbilicus get well without operation. He advises operation only when the bullet has escaped, and so its course is known, and when the general condition is good and there are signs of abdominal hæmorrhage continuing.

It must be remembered, however, that this refers only to wounds produced by bullets such as the Mauser, which does not spread on impact, is of small diameter, and has a great velocity. Where the bullet producing the wound is one which causes more damage than the Mauser, the expectant treatment is hardly likely to be successful, and in such cases it is certainly justifiable to urge *as early an operation as is possible after the diagnosis of peritonæal perforation is made.*

Bowlby in *A Civilian War Hospital* (1901) quotes the interesting case of a man who was wounded by a Krag bullet at target practice in the Philippines. The projectile entered two inches above the left costal margin in the mammary line, and took a downward course to the left loin, where it lodged. The patient was admitted into hospital within an hour, and Robinson decided to go against the usual practice and operate at once. On exploring through a wound near the middle line he discovered and removed a large amount of fluid and clotted blood; the bullet had pierced the omentum and mesentery, but had not injured the intestines; the vessels were tied, and the patient recovered. Several successful early operations were performed during the South African war, but the difficulties in the way of operating in time were very great, and the unfavourable conditions generally prevented such operations being done, or contributed towards their failure.

Different reasons are given for the spontaneous recoveries that more or less frequently occurred from wounds in which the projectiles must have traversed the intestinal area. Bowlby (*loc. supra cit.*) believes that the intestines entirely escape, and quotes Cheatle's case in support of this opinion. The patient was shot through the right loin, and the bullet emerged near the left anterior superior spine. After forty-eight hours the man died, and two small perforations were found in the

cæcum, and a laceration of the sigmoid, but no sign of injury of the small intestine; there was no peritonitis, which might have obliterated the evidence of perforation of the bowel. Bowlby states that as far as he is aware "the actual proof afforded by demonstration of wounded intestine which has healed is wanting." Such proof must be very difficult to obtain, of course, as the patients get well as a rule, and if any die from some other cause, all signs of small perforations may have become obliterated. There does not seem to be any reason why spontaneous recovery from very small perforations of empty small intestine should not occur occasionally, and such perforations of the stomach are well known to recover without operation sometimes, and the following is a good example (from the *Boston Med. and Surg. Journ.*, March 19, 1903). A soldier was shot from front to back in the epigastrium, and remained upon the ground without food for nine days; the enemy gave him water only; the stomach was probably empty at the time of the injury, and this no doubt accounted for the man's recovery. Some years afterwards he died, and it was found that the bullet had pierced both walls of the stomach.

Mr. Makins (*loc. cit.*) believes that the recoveries are largely due to the state of hunger at the time of the shooting and the very small amount of extravasation and infection, if any, that follows. The scarcity of drink and the enforced rest of the bowel and abdominal wall are also conducive to the spontaneous closure of the small perforations with lymph.

The minimal nature of the primary infection may be a factor, and this may be confirmed by the better prognosis of wounds of the large bowel except of those of the transverse colon, owing to the dryness of their contents and their comparative fixation, both of which limit extravasation (Makins). Patients with perforation of the peritoneal surfaces of the large intestine often got well after the formation and evacuation of a localised abscess, whereas Mr. Makins saw no similar recovery from perforation of the small intestine. He, therefore, concludes that spontaneous recovery after perforation of the small intestine must be very rare, but the absence of localised suppuration may be due to the less infective nature of the contents of the small intestine, especially during semi-starvation. After all, spontaneous recoveries are so rare and uncertain that under favourable circumstances the chances of the patient would be far better after an early exploration by a good surgeon. Unfortunately the circumstances of war are so unfavourable, that it is only occasionally possible to undertake operations early enough to arrest serious internal hæmorrhage or forestall the onset of peritonitis. Primary laparotomies were, therefore, very rare in the latter part of the South African war, and also in the practice of both Russian and Japanese surgeons during the recent war in the far East, and the excellent results obtained fully justified this line of treatment.

Mr. C. A. Gill (*Lancet*, 1906, vol. i. p. 1467) concludes from his experience of the South African and Japanese wars that there is a danger for the pendulum to swing too far towards non-interference, and he particularly draws attention to the need of more care in the early treatment and prevention of shock and sepsis. Each Japanese soldier carried tabloids of perchloride of mercury in addition to the usual first

field dressing. One or more tabloids can be dissolved in the soldier's water bottle, if no other receptacle is available. The wound should be cleaned and washed with the lotion, dried, and covered with the dressing. There should be facilities for urgent operations at the field hospitals, but all other operations should be deferred until the stationary field hospital or general hospital is reached.

Mr. Makins lays great stress on the need of absolute starvation in every case where perforation of the alimentary canal is suspected. At the end of twenty-four hours or more, warm water in small quantities may be cautiously given, and later milk, in teaspoonfuls only at first. Morphia should not be given in doubtful cases, for it masks the early symptoms of peritonitis, which should be carefully looked for, so that an operation may be undertaken if possible while there is still some hope of recovery.

Operation.—An excellent account of this will be found in the very helpful article of Prof. Nancrede to which reference has been already made.

With the utmost care the preliminary details of preparation are entered into first—viz., the cleaning and shaving of the skin, the providing of abundance of water recently sterilised by boiling, or a 2 per cent. solution of boracic acid, or a $\frac{1}{4}$ per cent. solution of salicylic acid, plenty of sterile gauze lying in the hot sterilised water, to cover the intestines with, abundance of ligatures of gut and silk of different sizes. In addition to the usual instruments, several pairs of intestinal clamps should be at hand, or failing these, strips of gauze may be passed through the mesenteries and clamped with Spencer Wells' forceps.

"Now as to technique. The patient's limbs and trunk must be carefully wrapped in blankets; and sterilised towels must be so arranged as to prevent any accidental contamination of the peritonæal cavity. If not previously done, the urine should now be drawn off. . . . Ether should be most cautiously administered. The incision should always be through the rectus sheath near the middle line,* as otherwise it is almost impossible to gain a proper view of the parts, and should usually extend from a short distance above the umbilicus to about two inches above the pubes. The rectus muscle is displaced outwards within its sheath, before the posterior layer of its sheath and peritonæum are incised. The abdomen having been opened, any clots or blood which obscure the operating field may be removed, but otherwise, unless it is manifest that severe hæmorrhage is going on, the small intestines,† which usually first present, should be carefully gone over, inch by inch, from the stomach to the ileo-cæcal valve, keeping them constantly enveloped in towels wrung out of

* This point has been much disputed. No hard-and-fast rule should be made, but as a rule the incision should be median. The late Mr. Greig Smith pointed out that the following cases require it: cases where the ball has crossed the middle line, entering at one side and passing towards the other, and others where the ball, entering near the middle line, passes either directly backwards or in an uncertain direction. I have alluded to this matter later (p. 437).

† Dr. Barnard (*loc. supra cit.*) points out that wounds of the duodenum are very rarely met with, and that wounds of the upper aspect of the transverse colon and of the omentum at this level are amongst the most difficult to discover.

hot water (sterilised). It is better to return each piece of intestine immediately after examining it, evisceration and its attendant dangers being avoided if possible. It is important to remember that the small intestine may move far away from the position which it occupied when injured, so that a bullet passing across the lower abdomen may pierce the intestines in several places, and some of these perforations may be discovered later at the upper part of the abdominal cavity. Therefore the only safe way is to examine every inch of small intestine carefully, however well and certainly the course of the bullet may be known. Makins (*loc. cit.*) draws attention to the fact that there is generally a characteristic area of redness around perforations of the intestines. This is of great help in finding the lesions. He also points out that wounds near the mesenteric border are quite common in military practice, which is in contrast with civil practice, and adds considerably to the risks of hæmorrhage and septic infection. Afterwards the stomach, spleen, liver, pancreas, large bowel, kidneys, bladder, omentum, mesentery,* and abdominal vessels must be examined. I do not mean that, if various wounds are discovered, say in the small intestine, and the place of exit of the ball from the abdominal cavity, all in such relations as would absolutely exclude injury of the stomach,† liver,

* "Wounds of the mesentery, when they are but perforations, can be passed without any additional interference, unless attended with hæmorrhage, in which case deligation of the injured vessel is required. Large lacerations should be closed with a running suture to avoid the future possibility of an incarceration and obstruction of a loop of the intestine in the opening. On account of the extreme delicacy of the membrane, its closure is often attended with some difficulty, which may be frequently overcome by introducing the sutures near the edge of a vessel, as this region affords the strongest grasp for the suture" (Shackner, *loc. supra cit.*). If it be the omentum which is wounded, or contains a large hæmatoma, it should be ligatured and cut away.

† Cases of wounds of all these viscera have been treated by laparotomy and suture. Thus, Mr. Dalton, of St. Louis (*Ann. of Surg.*, August, 1888), records a case of bullet-wound of stomach and liver thus treated successfully. The wounds in the stomach were those of entrance and exit, and situated, the former on the anterior surface, the latter near the upper border; both were closed with Lembert's sutures. The lower margin of the left lobe of the liver was ploughed through by the bullet an inch and a quarter from the transverse fissure, leaving a V-shaped wound half an inch in depth. This was closed by one catgut suture, of large size, passed on either side, an inch from the margin of the wound, and dipping deeply, on account of the great friability of the tissue, into the liver substance. "It acted well, bringing the wound together snugly." There were no other injuries save a slight contusion on the transverse colon, probably due to the spent violence of the ball, which was not found. The operation was rendered difficult by repeated vomiting of black grumous fluid, necessitating turning the patient on his side each time, "which was awkward with an open belly." The operation was a prompt one—two hours after the injury; recovery followed. In Dr. Keen's case (*Med. News*, May 14, 1887) the wound of entrance in the stomach was near the pylorus on the anterior surface, that of exit much more difficult to find, being on the lower border and posterior surface, and obscured by clot. Though there were other most serious injuries of superior mesenteric vein and right kidney requiring nephrectomy, the patient survived till the fifteenth day, death being due to diffuse suppuration of the clot in the mesentery, and gangrenous perforation at one spot in the intestine. Other means of meeting hæmorrhage from the liver are plugging with a tampon of aseptic gauze when the wound is large and the hæmorrhage great, and applying firm pressure, and, in the case of obstinate oozing from an abrasion, the application of a crystal of iron persulphate, or the Paquelin's cautery. Wounds in the gall-bladder are treated like those of intestine. Wounds of the kidney or

kidneys, spleen, or bladder, such a detailed examination should be made—far from it, for every unnecessary manipulation is injurious—but I do advise that, rather than overlook a wound, much manipulation which the result proves to have been unnecessary had better be made. Of course the source of a severe hæmorrhage must be at once sought for, and any wounds of the hollow viscera ignored for the time being, care, however, being taken that the general peritonæal cavity is protected from fæcal extravasation by removing the perforated loops of intestine outside the abdomen, keeping them wrapped in warm, moist cloths; such hæmorrhage is, however, most unusual. Whichever plan is pursued, let everything be done methodically, and each injury repaired as it is detected, as this saves much time and renders any oversight almost impossible. All wounds of the bowel, however trivial, should be minutely cleansed, coaptated by the Lembert suture of fine silk introduced with an ordinary sewing-needle, and the suture line rubbed over with a little iodoform.* The sutures should be introduced so that the sutured wound may be transverse to the axis of the bowel, in order to avoid narrowing of the lumen as far as possible. For large perforations two rows of sutures are safer, a deep one piercing all the layers, and an outer sero-muscular stitch. In smaller punctures, a sero-muscular pursestring suture, as recommended by Senn, may suffice (*Journ. Amer. Med. Assoc.*, Nov. 8, 1902). “When necessary from the size or number of the wounds, a portion or whole calibre of the gut must be excised.† Wounds of the liver, if situated at the free border of the organ, should, if possible, be coaptated with dry aseptic gut, which will soon swell and fill the track made by the needles. If this cannot be done, the hæmorrhage may perhaps be arrested by the judicious use of the thermo-cautery. Unless the bleeding be free, the wound should be plugged with an iodoform-gauze tampon, which is to remain for forty-eight hours.”

“Wounds of the pancreas” (*vide* Ch. X.), “spleen, or kidneys must be treated in a similar manner, or, if these measures fail, either spleen or kidney must be excised. Since a wounded splenic artery would lead to gangrene of the organ, it must be removed” (*vide* p. 528). “The same advice holds good for wound of a renal artery, but in these cases death from hæmorrhage will usually result before art can intervene; still such possible complications must be provided for. Wounds of the bladder had best be sewn with inverting sero-muscular sutures of silk or reliable catgut in one or two layers; and

spleen must be treated, according to their nature, either by suture, as in the liver, or by gauze packing. If the hæmorrhage is too severe for the above, the organ must be removed. Dr. Keen in his case alluded to above, the kidney being badly lacerated, adopted this step. The ureter should be examined, and, if found divided, sutured, or failing this, the kidney should be removed.

* Wherever possible, the sutures should be introduced parallel with the long axis of the intestine, as by this its lumen is least narrowed.

† Of all the wounds of the intestine those of the rectum are most difficult to detect, and therefore very fatal. Dr. Morton (*loc. supra cit.*) suggests that inflation with a rubber bag may be of assistance here. He also alludes to two cases in which the diaphragm was wounded. In each case a hernia of viscera into the thorax existed; this was reduced, the wound sutured with catgut, and recovery ensued.

the needle should be a round one, as small as can be made to carry the thread. Contused bowel will almost certainly slough, so that the injured portion had better be excised and the healthy peritonæal surfaces united by suture. Wounded or contused omentum or mesentery must also be excised, and the edges carefully united by interrupted sutures. The experience of at least one case has shown that since an omental slough cannot be eliminated into the lumen of the bowel, as occurs in wounds of the intestine, a fatal generalised peritonitis will result from the local gangrene. All bleeding must be checked, even from the smallest vessels, for quite extensive oozing will occur from most insignificant vascular orifices, because they are situated in a closed cavity, and, although the amount lost may not be dangerous *per se*, it will prove so as a source of septicæmia or peritonitis."

This was so in Dr. Keen's case (*loc. supra cit.*). The hæmorrhage here extended fan-shaped in a moderately thick layer between the two layers of the mesentery, its periphery extending almost two feet along the bowel, and its point being at the mesenteric attachment to the spine. The chief bleeding came from a hole in the superior mesenteric vein, and was secured, after much difficulty, by a laterally placed ligature of chromic gut. In spite of the most careful antiseptic precautions and unremitting after-treatment, the patient died, on the fifteenth day, of suppuration in this clot, and gangrene of the intestine connected with this part of the mesentery. Wounds of the spleen must be treated by the methods already given for the liver and kidney. The treatment of those in the bladder is given fully later.

If a segment of bowel is to be excised, the cuts should be made at such points as correspond to the distribution of a large mesenteric branch in order to secure a due blood-supply to the edges of the incisions, and the parts to be removed should be laid upon a large flat sponge, or folded napkins, to prevent fæcal extravasation into the abdominal cavity. To avoid escape of fæces during excision of intestine, the simplest of all clamps is small rubber tubing made to pierce the mesentery on each side of the wound, at a spot devoid of vessels, passed round the intestine, and knotted once, or, better, clamped with Spencer Wells's forceps (Dr. Shackner, *Ann. of Surg.*, June, 1890). Proper intestinal clamp forceps, such as those of Doyen or Carwardine, are far more useful than rubber tubing; and if sheathed in tubing and not clamped too lightly, they need not damage the intestine. For a rapid resection Barker's method is an excellent one. The mesentery should be tied before it is divided, parallel with and near the bowel; and if the ligatures are applied as recommended by Mr. Barker, very few are required, and no rent remains needing suture. Moreover, no kink occurs at the mesenteric border of the sutured bowel (*vide p.* 398).

"Should the pulse fail at any time during the operation, owing to irritation and paresis of the abdominal sympathetic, flushing the intestines and peritonæal cavity with hot water will often at once remove the unfavourable condition. The most scrupulous care must be exercised in the peritonæal toilet, which can be most quickly and effectively made by thorough irrigation of the cavity with warm sterilised water, and subsequent careful removal of all fluid in the

ordinary manner by gauze rolls, especial attention being paid to the case of the pelvis and the renal regions.

"When possible, the peritonæum should be united over the orifices of entrance and exit of the ball,* and a little iodoform rubbed in. . . .

When incipient peritonitis exists, or a faecal extravasation has occurred, drainage should be established by means of cigarette drains passed into the pelvis, and in the various other directions that may be indicated by the position of the sutured perforations. If all goes well these drains may be removed after thirty-six hours, but if pus is coming away the tubes must be sterilised and replaced. The patient should be propped up in the Fowler position to facilitate drainage.

Le Conte advises drainage through the loin in cases in which the lesser sac has been opened. This provides better drainage, but care must be taken to avoid the important structures lying behind the lesser sac.

As many of the above points may be considered to be unsettled till more cases give us better light, I have added, for contrast, the views of another American surgeon, Dr. McGraw, of Detroit (*Trans. Amer. Surg. Assoc.*, May, 1889). It will be seen that in some most important points—*e.g.*, the site of the incision and the question of how best to examine the intestines—they are directly opposed to those of Dr. Nancrede. Dr. McGraw's chief propositions are as follows:—

(i.) Bullets which enter the abdominal cavity pass in a nearly absolutely straight line from the orifice of entrance to that of exit, or their final stopping-place in the viscera. (ii.) An incision made directly in the course of the ball will give the shortest route to the injured parts. If balls pass through the abdomen in straight lines, a cut over the path of a ball will open the nearest possible way to the wound underneath, provided the viscera have not shifted their places since the shooting. Even then they could be easily brought into the wound for the purpose of repair. Coils of viscera which could not be so brought could not possibly have been struck by the ball. I disagree with this view, for recent records show very clearly that it is not safe to arrive at conclusions from the probable course of the bullet, and that a thorough examination is the only certain and reliable way of finding out the extent of the internal injuries. Such an examination can be best made through an incision near the middle line, where the length of the wound can be increased to the desired degree without the same risk of ventral hernia as must be associated with extensive lateral or irregular wounds. The aponeurosis of the rectus sheath should be overlapped as usual. (iii.) If a gunshot wound of the intestine will not under pressure permit discharge of its contents, it has been closed by the eversion of the mucous membrane or by the exudation of plastic lymph. In either case the wound would probably recover without suture if kept perfectly aseptic, and if the bowels are kept perfectly quiet, but no one should put his trust in such a possibility, and every perforation must be closed and inverted if practicable. (iv.) An empty condition of the alimentary canal is most favourable for healing. To secure

* If the track of the ball is likely to be septic, it should be treated by incision, cleansing, and drainage.

this as far as possible, it may be proper, in some cases of injury of the bowel after a hearty meal, to evacuate the stomach by a syphon. This would be especially indicated in wounds of the stomach, duodenum, and upper part of the jejunum, whether the surgeon does or does not decide on operative treatment. (v.) Senn's method of hydrogen-gas insufflation, however admirable in recent cases, should be used with great caution after the lapse of a few hours. The distension and motion of the gut caused by the insufflation might rupture inflammatory adhesions, break open intestinal wounds that had nearly healed, and make general a peritonitis which had become circumscribed. It may be added that it also wastes valuable time, and increases distension, which seriously interferes with a successful laparotomy later. It is not surprising that this method has been generally discarded. (vi.) The dangers of the operation are directly in proportion to its length and to the amount of evisceration. The length of an operation may be lessened—(1) By strictly limiting the examination of the viscera to such of them as may have been in the course of the ball. (2) By suturing wounds in the gut, wherever it is possible, instead of excising them. The latter should be reserved for wounds that do not permit inversion and suture. (3) By omitting all operative procedures, even suture, in all wounds which have become so thoroughly occluded by plastic material that the contents of the bowel cannot be passed through them. (4) When many wounds occur near together by operating first on those wounds which imperatively demand it, and leaving to the last those which may recover without operation. If the stomach and intestine are both perforated, the small intestine should be first attended to, as the stomach, if empty, may recover without suture. So, too, large wounds should be sutured before small ones, discharging wounds before those which are occluded. (5) By never turning out all the intestines except, first, when hæmorrhage is otherwise uncontrollable, or, second, when there is evidently a discharging wound which cannot otherwise be found. "The examination of the whole intestine by slipping it, from one end to the other, through the fingers, though not causing the exposure of evisceration, nevertheless consumes an enormous amount of time, and reduces very materially the strength of the patient. In my opinion, surgeons have exaggerated the difficulties in the way of discovering wounds which have made this procedure necessary. The incision over the course of the ball will aid materially in the diagnosis by exclusion, for no intestine which cannot be brought into the path of the missile could possibly have been hit by it. It is not probable that a gut would slip more than three or four inches away from the place it occupied when wounded, and, with the incision I have mentioned, the necessity would rarely occur of examining any other viscera than those in the immediate neighbourhood of the wound." "Let us suppose that a surgeon in operating has repaired all the wounds he has been able to find in or near the course of the ball; he has washed out the abdominal cavity; he has with his hands gently pressed upon all the viscera which could possibly have been injured, and his hands have come out unstained; he has furthermore with soft sponges wiped out the lower part of the abdominal cavity without finding blood or fæces. Shall he then, without any evidence whatever of an additional wound,

subject his already exhausted patient to a most dangerous procedure on the mere suspicion that there might be a still undiscovered wound?" Many recently published cases prove that this conclusion is not warranted, and the following case illustrates this point. The bullet entered above and behind the left anterior superior spine of the ilium. At the operation, which took place within an hour, Harris discovered two perforations in the sigmoid flexure, one very low down, four perforations of the jejunum near the middle of it. "These were thought to be all the perforations, but the colon and stomach were examined as a matter of routine. On drawing down the transverse colon, which was well to the upper part of the abdomen, much to our surprise, two perforations were found in it. It seems almost impossible that a bullet entering at the point indicated in this case, and travelling approximately from before backward, could perforate the sigmoid low down the transverse colon twice, and the jejunum four times, yet such are the facts, which are explainable by the great mobility of nearly all parts of the intestinal tract." The patient died of peritonitis, but all the perforations had been well closed (Harris, *loc. supra cit.*).

It will be seen that the diversity of opinion as to the site of the incision, and the desirability of turning out all the intestines for examination, turns on the question of how best all injuries of the peritonæal sac can be detected. The advocates of the latter step and median free incision claim that by this alone can the needful inspection be made of all the viscera, both free and fixed, hollow and solid; they point to numerous cases in which even by this means of complete examination injuries have been overlooked that have marred the success of an otherwise complete and most hopeful operation; they hold that the median incision alone will meet those cases where the course of the ball is not direct, but erratic, or where by moving the patient a long distance, or from peritonitis setting in late, peristalsis has altered the position of the bowels. I think the published evidence shows clearly that the median incision is the wiser, save in a few cases, as where the wound lies well away to one side, as here the colon may be found shot through, and only this organ and the contiguous small intestine and the kidney behind will require examination. It must not be forgotten that with the great advantage of more complete exploration which the median incision affords goes the greater risk of shock and of general contamination of the peritonæal sac, as coils which are possibly leaking are drawn up into the wound. This will have to be met by careful irrigation later. With regard to turning out all the intestines, the advocates of this plan claim that by this alone can all the wounds be found, and that this step, by the more rapid searching which it allows, in reality diminishes shock. Till more cases have been published—and surgeons owe a great debt to the candour and fulness with which the American surgeons have made known their failures as well as their successes—each case must be decided on its merits. In early operations evisceration does not involve much danger from shock, for the intestines can be easily replaced. On the other hand, it is rarely necessary in these cases, for a satisfactory examination can be made without it. In late cases, with peritonitis and distension of the intestines, evisceration is a serious thing, for it may be very difficult to replace the intestines afterwards, and shock is greatly increased

by exposure, traction of the coils on the mesentery, and the manipulations which are necessary to get the intestines back again. The points which will aid the surgeon in coming to a decision on the above two steps are any obliquity of the wound of entrance, and of the course of the ball; the position of the wound of entrance, whether near the middle or the lateral parts of the abdomen; any evidence of its having passed from side to side; entire uncertainty as to its course; the time that has elapsed since the injury; the interval between this and the last meal; and whether the patient has been kept quiet.

In cases where the presence of multiple wounds, or the severity of one, entails the risk of sloughing, or where multiple suturing will produce dangerous stenosis, resection must be performed on the lines already fully given at pp. 388, 393. Two very interesting cases are recorded by American surgeons in which Murphy's button was employed successfully. In one (Dr. G. F. Wilson, *Ann. of Surg.*, September, 1895), after one wound of the ileum had been found, and closed with Lembert's sutures, eight other openings were found, at a considerable distance from the first, three being very close together. Again, some little distance further off, the bullet had passed through the mesenteric border of the intestine, so interrupting the blood-supply that a slough would surely have resulted. A single resection was accordingly determined on, and the portion removed measured, without stretching, just forty-three inches. The patient recovered, and the button was passed on the ninth day. In the second case (Dr. J. W. Walker, *Ann. of Surg.*, January, 1896), a resection of two inches of the ileum was successfully performed. The button was here passed on the fifteenth day. As Dr. Walker remarks, if Murphy's button be used at one place and another wound require suture lower down, any unavoidable constriction which the latter may occasion will cause anxiety as to the safe passage of the button. Many successful cases have been published since. Nearly all experienced surgeons prefer direct suture to mechanical contrivances, but there is little doubt but that the Murphy button is safer for the inexperienced worker under difficult circumstances.

The chief points in the after-treatment are—rectal feeding for forty-eight hours or longer if the stomach or upper part of the intestine has been injured; morphine injections, combined with atropine (about $\frac{1}{60}$ gr.), for the first thirty-six or forty-eight hours, rather than opium; careful use of saline aperients—*c.g.*, Seidlitz powders—a little later.

I append the following as instances of what injuries the surgeon may expect to have to deal with:—Bullet wound near umbilicus; seven openings in alimentary canal, viz., three openings close together in the small intestine (three and a quarter feet below the duodenum), two openings in the descending colon, and two in the rectum; no great extravasation; also a large vein wound in the mesentery; death from peritonitis; bullet found near ischial spine (Annandale, *Lancet*, April 15, 1885). Pistol wound near navel: seventeen hours later, operation (two pints of bloody serum let out, with small clots, but no fæces); seven penetrating wounds of intestine, six in the small, one in the sigmoid containing the bullet; all the openings plugged with ragged, everted mucous membrane; no fæcal escape till edges were separated; careful suturing and toilet; recovery after a very critical condition for a week

(Bull, *Ann. of Surg.*, May, 1885). Bullet entrance close to navel: operation two hours later; abdominal cavity full of blood; a spurting artery in the mesentery; eleven wounds requiring suture in small intestine, and two in ascending colon; no fæcal extravasation, but a melon-seed body found and removed; on the thirteenth day great rectal tenesmus led to discovery of blood-effusion in pelvis; three pints let out by incision about two inches within anus; recovery; bullet passed per anum (Hamilton, *Journ. Amer. Med. Assoc.*, Aug. 22, 1885; *Ann. of Surg.*, November, 1885). Bullet entrance three and a half inches above umbilicus, and just to left of middle line: operation within twenty-four hours; rent in omentum close to great curvature of stomach, and two linear rents in this viscus, found with much difficulty; operation had to be concluded quickly from patient's critical condition; death from acute peritonitis within a few hours; four wounds found in upper part of jejunum, all within a distance of three inches (Bridson, New York Surg. Soc., Dec. 8, 1886; *Ann. of Surg.*, April, 1887). Bullet wound two inches above and two inches inside right anterior superior spine: operation in nine hours; wound found in ascending colon, pouring out fæces; another wound in colon, also pouring out fæces; both sutured; recovery (McGraw, *Chicago Med. Journ. and Exam.*, July, 1887; *Ann. of Surg.*, December, 1887).

A very complete table, containing 234 cases, is given by Dr. T. S. K. Morton (*Journ. Amer. Med. Assoc.*, Jan. 4, 1890); others by Sir W. MacCormac and Mr. Barker will be found in the *Brit. Med. Journ.*, May 11, 1887, and March 17, 1888.

Other papers will be found in the *Annals of Surgery*. One of the most interesting is by Dr. A. B. Miles (vol. ii. 1893, p. 623). Thirteen cases are given, with five recoveries. In proof of the severity of these cases, of the recoveries one patient had sixteen, another fourteen, and a third ten wounds of the small intestine. One of the fatal cases was due to the discharge of both barrels of an ordinary shot-gun into the right iliac fossa.

The valuable contributions of Makins, Bowlby, Stevenson, Treves, and others upon the South African war have been already referred to. Still more recent and some very instructive papers have been written by Harris, Fenner, Gill, Le Conte, La Garde, and have been alluded to.

An interesting case is recorded by Senn (*Ann. of Surg.*, 1905, vol. xli. p. 637). The jejunum, ileum, hepatic flexure of the colon, ascending colon, and cæcum were wounded. Some of the jejunum had to be resected, the other intestinal and some mesenteric wounds were closed mostly by two rows of sutures, the peritonæum was wiped out, and the patient recovered.

Brewer (*Ann. of Surg.*, 1904, vol. xxxix. p. 100) records a successful operation for a pistol wound of the liver, gall-bladder and stomach, and mesocolon; three perforations of the stomach and one ragged one in the gall-bladder were sutured, and much blood removed. Two days later the wound had to be reopened owing to an accumulation of biliary discharge from the liver wound.

RUPTURE OF THE INTESTINE.

The following remarks are taken from the Cartwright Prize Essay by Dr. B. F. Curtis, of New York (*Amer. Journ. Med. Sci.*, October, 1887):

Relative frequency of rupture in 113 cases.—Duodenum, 6; jejunum, 44; ileum, 38; “other parts of small intestine,” 21; large intestine, 4. While the duodenum and large intestine escape from their sheltered position, the jejunum is most frequently ruptured in its first three feet, the ileum in its last three. Fæcal extravasation is almost invariably present. The most frequent and important complication of ruptured intestine is laceration or contusion of the mesentery; this is important from the rapidly fatal hæmorrhage, or later gangrene. The cases of ruptured intestine fall clinically into three classes. (A) The shock never leaves the patient, may never lessen, but pass, rapidly or slowly, into fatal collapse. This may be due (1) to the shock of the accident; (2) to hæmorrhage; (3) to fæcal extravasation. (B) Those in which evident peritonitis develops. The diagnosis is easiest in these cases, but unfortunately they are not the most common. (C) The most common. Instead of evident peritonitis setting in after reaction has taken place, vague symptoms appear, keeping the surgeon in expectation of it, but giving nothing on which he can found a positive diagnosis, for the same slight indications are common in cases in which ultimate recovery has taken place. Patient is apathetic, seemingly satisfied with his condition, and thus misleading; or, getting gradually weaker, and therefore being less able to complain, appears to be improving. Peritonitis in this group of cases develops so slowly that its beginning cannot be noted. *Duration of life*.—The average taken from 113 cases is forty-eight hours. *Chief points in the diagnosis of rupture of intestine*.—Cause, e.g., a kick. This was so in 28 per cent. of the cases. The intestine is crushed between the spine and the force employed. The severer the injury—e.g., a kick by a horse—the more likely is the intestine to have been injured. Senn (*Amer. Journ. Med. Sci.*, June, 1904) draws attention to the possible occurrence of rupture of the intestine from indirect violence, such as falls upon the buttocks, and records the interesting case of a woman who fell upon the right buttock, and six hours later was seized with violent abdominal pain. When Senn saw her two days later, she was very ill with general peritonitis, and upon exploring a small laceration of the jejunum was discovered after a long search. As the patient was in a very grave condition, the perforation was sutured to the abdominal wound. Rectal feeding was adopted for eleven weeks, during which time several attempts were made to close the fistula by means of the cautery. Resection was ultimately performed, and proved successful. Rigidity of the abdominal wall and pain and tenderness at one spot are the most reliable symptoms. Tympanites, a later sign,* is of grave omen, as it greatly embarrasses operative interference. Shock† and vomiting afford less valuable evidence, unless persistent. The absence of each has led to fatal delays. Le Conte (*Ann. of Surg.* 1903, vol. xxxvii. p. 525), in his address on “Surgery” before the Philadelphia Academy of Surgery, discusses the diagnosis of intestinal injuries very thoroughly, and lays stress upon the importance

* When present early and abolishing the liver dulness this is almost pathognomonic of injury to the alimentary canal.

† Shock is quite unreliable, as it depends not only on the severity of the injury, but on the idiosyncrasy of the patient.

and gravity of a steadily increasing pulse rate, an anxious, careworn, and painful expression of the face, and the recurrence of vomiting after reaction. Brewer also read a valuable paper upon this subject before the New York Surgical Society (*Ann. of Surg.*, 1903, vol. xxxvii. p. 197), and strongly advocates early operation. He places most reliance upon the association of pain, tenderness, and rigidity. Evidence of the presence of free fluid in the peritonæum is also important. The signs of internal hæmorrhage have already been alluded to at p. 423. A certain diagnosis is seldom possible for twelve hours or longer, but the surgeon should not wait on this account. The risk nowadays of doing harm by exploring, in cases where no laceration of the intestine or mesentery is present, is much less than that of waiting to explore until the onset of a septic peritonitis affords certain evidence. As in intestinal obstruction, abdominal section is the only means of clearing up the diagnosis.

Mr. Robson (*Clin. Soc. Trans.*, vol. xxi. p. 130) advises as follows on the question of operation: "In cases of doubt one is so prone to wait, hoping for the turn of events, and then to arrange to operate when too late, that it is well to have some formulated rule, and for my own guidance I have adopted the following. In cases where there is a reasonable belief that the intestine is wounded exploration by a small median incision must be made, when, if there is any rupture of the bowel, flatus, or serum tinged with blood, or fæculent material will escape through the small peritonæal opening, which can be enlarged and necessary treatment adopted; but should no flatus or fluid appear and the peritonæum prove to be healthy, the small wound can be closed."

That the best chance is afforded by early operation, as soon as the period of shock has passed off, is proved by recorded results (Battle). This surgeon points out (*loc. infra cit.*) that in the second paper read before the Clinical Society (*Trans.*, 1890) by Mr. Croft, out of 14 cases then collected only one was completely successful, a case operated on by Mr. Croft; and between 1890 and 1894 Mr. Battle had collected 15 cases, seven of which recovered. Senn states that retro-peritonæal emphysema indicates an injury of the duodenum or colon. The prognosis depends on the extent of injury, the amount of extravasation, and the amount of delay before operating. Siegel collected 376 cases which were operated upon, with a mortality of 51·6 per cent. The following figures concerning these cases prove the importance and value of early operation:—

Cases operated upon first 4 hours, mortality.		15·2 %
" " " " 5 to 8 hours, mortality .		44·4 %
" " " " 9 to 12 hours, mortality .		63·6 %
" " " " later		70·0 %

Treatment.—Where rupture of intestine or severe hæmorrhage is probably present, exploration should take place as soon as possible, shock being combated by infusion and injection of adrenalin, ergot, or strychnine, before, during, or after the operation. Valuable time should not be wasted in the hope that the shock may pass off, for it may never do so, and meanwhile peritonitis is developing; ether is the best anæsthetic to choose. The incision should be near the middle line and should be a long one, at least four inches, the parietes here being

normal, not distended and atrophied, as in abdominal tumours. When all the intestine has to be drawn out and examined—and no operation can be otherwise complete—the incision should be eight inches long. In any case the centre should be at the umbilicus, unless it is clear that it is the stomach that is injured. It should not be lower down, or the attachment of the mesentery may interfere with the pulling out of the intestine, especially if it be short and thickened with fat. Blood may show through the peritonæum before this is opened. When this membrane is incised a sponge should be passed in on clamp-forceps to search for blood, fæces, or pus. If hæmorrhage is going on, the opening the abdomen may stop it (Parkes, *Med. News*, May 17, 1884), or it may increase, causing grave symptoms. If blood well up, a hand should be passed in, under the omentum, upwards and backwards, to make pressure on the abdominal aorta and root of the mesentery. All the small intestine is then turned out into hot aseptic towels; bleeding points are found, and secured with clamp-forceps, while the pressure is relaxed to note the effect on the bleeding. The bleeding having been arrested, any injury to the intestine is sought for. If a rupture is found, the part should be kept outside in a hot aseptic towel, while the rest is returned. If hæmorrhage is slight or absent, the intestine should be drawn out loop by loop, and inspected till the whole is examined. Fæcal extravasation should be avoided by extremely careful handling of the intestine, the wound thus remaining unsoiled. When all the intestine has been inspected, the peritonæal sac should be carefully cleansed, as at p. 336. Any distended coil may be aspirated, and the puncture tied up or opened, as at pp. 264, 335. Small ruptures will often admit of suture without resection. When the case is too grave to admit of resection being performed and of the necessary plastic repair taking place, the best course is to make an artificial anus by closing the ends of the intestine with ligatures or clamps; then, having thoroughly cleansed the peritonæal sac, next bring the ends out and insert Paul's tube (pp. 349, 387), or suture the ends of the intestine to the margins of the wound. Resection takes very little more time, however, and is to be preferred except in the gravest cases, where intestinal drainage is imperative (*vide* p. 393). This course ought not to take more than half an hour. Where the injury is high up in the intestine (*vide* p. 415) additional risk must be run in order to avoid, by resection, the artificial anus, which is so harmful here. If the anus be made use of, it should be closed as early as possible, or the nutrition will suffer fatally (p. 415). Other viscera may be injured and have to be dealt with; thus lacerations of the liver, spleen, or kidney may be sutured or packed with gauze. Brewer (*loc. cit.*) advocates packing in preference to splenectomy in all but the gravest fractures of the spleen, this plan saving time and being attended with less shock; it also preserves a valuable organ. The risks of reactionary hæmorrhage are greater, however. Nephrectomy is necessary in some cases; lacerations of the pancreas are generally beyond surgical treatment, on account of the associated lesions, the profound shock, and the difficulties of arresting hæmorrhage; glycosuria may indicate the occurrence of this serious injury, as in a recent case under the care of Mr. Clement Lucas (*vide* Ch. X.). Saline infusion may be resorted to with great advantage early in the operation, before collapse, perhaps irrecoverable, has set in. No

operation should be performed if grave collapse is present. If the patient does not respond to stimuli, he will not survive laparotomy.

The following are some of the conditions which have been met with in exploration of injury to the intestine :—

In Dr. Wiggins' case, to which I have already alluded, thirty-six hours after the boy had been kicked by a horse, the abdomen was opened and the small intestine withdrawn and carefully examined, beginning with the ileo-cæcal region. Near the jejunum a bruised and livid knuckle was discovered. Though no perforation was made out in it prior to the resection, a small perforation was found afterwards near the mesenteric border. About six inches were resected, the ends being united by Maunsell's method. Owing to the patient "coming-to" and straining while the resection was being performed, blood and faecal matter escaped into the peritonæal sac, this accident being due to the safety-pins used as clamps being too large. A 50 per cent. solution of hydrogen dioxide was poured in, and allowed to remain while the ends were being united, and the cavity was afterwards flushed with, and finally left full of, sterilised salt solution. The patient, a boy aged 15, made a good recovery (*New York Med. Journ.*, Jan. 20, 1894).

In a case fully reported by Mr. Battle (*Lancet*, vol. i. 1894, p. 1121, a paper which will well repay perusal), the following was the condition present when the peritonæum was opened* :—

A gush of blood followed, and, as the patient was straining, a coil of intestine was forced out. A rent was found in the mesentery of this coil, bleeding freely. While this hæmorrhage was being arrested with clamp-forceps, the open end of a piece of intestine sprang into the wound. The other end was found by tracing the mesentery along. This portion of mesentery was much contused and lacerated, and there was a second complete rupture, about eight inches from the first. Only a small portion of the contents had escaped, among which were one or two partly digested beans. As it was evident that the condition of the mesentery would result in gangrene if it were left, resection was performed, nearly thirteen inches being removed with a large wedge-shaped piece of mesentery. While a lateral anastomosis was being performed here by Senn's method, it was discovered that a third rupture existed, about a foot beyond the second. This rupture was not quite complete. It was closed "by means of Senn's plates, cut to the required size, and a ring of Lembert's sutures used to further strengthen the union."† The patient did well until the fifth day, when evidence of perforated peritonitis appeared. The abdomen was again opened, and it was found that the end to end union had broken down, leading to leakage. An artificial anus was made, but the patient never rallied.

Mr. Croft has recorded two cases of rupture of the small intestine without external wound (*Clin. Soc. Trans.*, vol. xxi. p. 254, and vol. xxiii. p. 141). These must be looked upon as pioneering cases, as far as this country goes, in the modern treatment of these injuries. Both patients recovered—the one completely, after primary enterorrhaphy by Lembert's method; in the other case an artificial anus was made. This was closed by resection of the intestines four weeks later, but the patient sank, thirteen hours after the operation, from exhaustion, due chiefly to "the irrepressible escape of intestinal contents at

* The patient, aged 24, had been kicked in the abdomen by a horse. He was admitted into St. Thomas's Hospital shortly after, and was operated upon about six hours later, when the shock had passed off.

† This operation lasted over two hours, and, owing to the increased shock, five pints of saline solution were injected with a good effect.

the artificial anus." The following points amongst many others are noteworthy in the two last instructive cases :—

In the first case, three separate lesions were discovered ; the ileum had been ruptured transversely for two-thirds of its circumference at the junction of its upper and middle thirds. There was a laceration of an inch and a half in the mesentery in the same neighbourhood, and a considerable rent in the omentum above the level of the umbilicus. Fæcal peritonitis had spread from the ruptured intestine into the iliac, umbilical, and hypogastric regions, eighteen hours and a half having elapsed between the injury and the operation. The peritonæum was very carefully irrigated with warm boracic acid solution (from 16 to 20 per cent.), and the edges of the ruptured intestine brought out into the wound. Mr. Croft points out that the result of this case shows that it would probably have been a safe practice to have trimmed the edges of the ruptured gut and completed an enterorrhaphy by Lembert's sutures, as the irrigation was evidently efficient. This would have saved the inanition and debility consequent on the establishment of an artificial anus, the external irritation and the septic condition of the parts around the opening, and the second long and risky operation required to close it.

In the second case, fourteen hours had elapsed between the operation and the kick from a horse. A faint fæcal odour was observed when the peritonæal sac was opened, and about an ounce and a half of fæcal fluid was found extravasated between some coils of intestine adherent to each other and the omentum. On tearing through the adhesions and separating the coils on the right side, about two inches below the umbilicus, a small rupture was found in the ileum, situated in an areola of inflamed and ecchymosed tissue. Resection of the damaged intestine was performed, the ends being united by about forty Lembert's sutures. The peritonæal sac was carefully purified with a hot 20 per cent. solution of boracic acid. The patient, aged 14, made an uninterrupted recovery.

I can only find space for one other of these most interesting cases. It is recorded by Mr. W. T. Thomas, assistant surgeon to the Royal Infirmary at Liverpool (*Brit. Med. Journ.*, vol. i. 1894, p. 1355). It presents the following points of interest :—

(1) The slightrness of the injury. The patient, aged 55, had, twenty-four hours before the operation, struck her abdomen against a chair which she was carrying before her, and which caught against a doorpost. (2) The absence of symptoms in a case of severe septic peritonitis, only distension and tenderness being present. When the abdomen was opened, about half a pint of putrid serum, with large yellowish flakes of puriform lymph, escaped. The intestines were all distended, and, as no collapsed coils could be found, the small intestine was withdrawn. After two feet had been examined, a perforation was found* about three-quarters of an inch long, from which oozed fæcal fluid. This was closed by two rows of continuous Lembert's sutures, the mucous membrane being carefully tucked in. Thorough irrigation with a 1 per cent. solution of carbolic acid was then carried out, a glass tube being left in. The patient made a good recovery.

Interesting and instructive cases will be found related in the recent papers of Brewer, Senn, and Le Conte, which have been already referred to ; and recoveries are now fairly common at all large general hospitals.

* The site of the rupture was not given, nor is it stated whether much difficulty was met with in dealing with the distended intestines.

CHAPTER VII.

OPERATIONS ON THE STOMACH.

GASTROSTOMY.—GASTROTOMY.—DIGITAL DILATATION OF PYLORUS.—PYLOROPLASTY.—GASTRO-DUODENOSTOMY.—PARTIAL GASTRECTOMY.—GASTROCTOMY.—GASTRO-JEJUNOSTOMY.—DUODENOSTOMY AND JEJUNOSTOMY.

GASTROSTEMY.

Indications.

1. Certain cases of cancerous stricture. This also includes invasion of the œsophagus secondarily from primary cancer of the mediastinal glands, &c. 2. Cancerous disease of the pharynx; and, in a few cases, malignant disease of the tonsil or back of the tongue not admitting of operation.

A very interesting case is given by Mr. Whitehead (*Brit. Med. Journ.*, July 22, 1882). Here, in a patient aged 40, excision of the tongue had to be followed by tracheotomy and gastrostomy, owing to the original extent of the disease. At the last report the patient was alive, four months after the gastrostomy, five after the removal of the tongue. Two such cases are given by Mr. Stonham (*Lancet*, Oct. 2, 1886). One patient survived four months, the other one. In this case the growth was so extensive as to necessitate tracheotomy at an early stage of the gastrostomy. Both patients experienced great relief. Tracheotomy was also required in Mr. King Green's case (*Lancet*, Feb. 3, 1883), though here the disease was either in the pharynx or upper part of the œsophagus. I think that in such cases, also, the last few months of life might often be rendered much more comfortable by a timely gastrostomy. M. Morestin (*Lancet*, 1906, vol. i. p. 634) has recently drawn attention to this subject again.

3. Cicatricial stricture, whether traumatic or syphilitic.

The first of these, from its frequency, requires separate notice.

1. Cancerous Stricture.—Here several points call for attention. Amongst the chief are—the question of the treatment of œsophageal cancer by passage of tubes or gastrostomy, the mortality of the latter operation, and the best date for performing it.

The following remarks by Mr. Symonds are of value in view of his large experience of these cases:—

“I would put the general question of treatment in the following way as applying to all cases. (1) While the patient can swallow fluids and semi-solids, and while a bougie can be passed and plenty of nourishment taken, he may be left alone so long as (a) he can swallow well or (b) a small bougie, No. 12 catheter gauge, can be passed. (2) If the dysphagia increases, even though a bougie can be passed, then a tube must be inserted, or gastrostomy must be performed. These conditions

are seen in the soft fungating forms. (3) If a bougie cannot be passed, or goes with difficulty, then the same course must be followed, as we know that complete closure may occur at any time. (4) If both conditions arise—*i.e.*, the patient cannot swallow, and a bougie cannot be passed—then immediate mechanical treatment is required" (*Lancet*, 1902, vol. ii. p. 351).

Between treatment by gastrostomy and that by tubes no fair comparison can be made, because the former operation has, in such a large number of cases, been performed under most unfavourable conditions. Much too often it has been put off till the patient, scarcely able to swallow liquids, is just kept alive by enemata. Such patients, worn out by the miseries of slow starvation, often with secondary disease and lung and pleural trouble, are not in a condition to be submitted to abdominal section, and are not likely to respond to the call made upon their vitality to unite two serous surfaces firmly together, on which depends the success of the operation. I do not think that I exaggerate if I say that, in a distinct proportion of the cases in which the surgeon is asked to perform gastrostomy, the hand of death is already on the patient, and something next door to the decomposition of the grave has already set in, owing to the extension of the disease.

In advising gastrostomy, each case must be decided on its merits; the patients here are not only adults, but well on in life, and, when assured that the end is certain, the surgeon may in most cases, having put all the risks before the patient, leave it to him to decide. But I think that if the patient, having previously declined it, only asks for operation when it is clearly too late, the surgeon should be firm enough to decline to operate where, on every ground, his interference will be hopeless.

The following points help in a decision between gastrostomy, bougies, and tubage: i. Food taken.—As long as pulpy, semi-solid, or a proportion of solid food is taken, the occasional passage of a bougie should be persevered with. Bougies should not be passed for the object of dilating the stricture. "It is injurious in that it irritates and leads to increase of obstruction; it may split a hard stricture, and set up rigor and fever from absorption" (Symonds, *Lancet*, vol. ii. 1902, p. 353). A small bougie may be passed, "simply to secure the route, so that at any time a tube can be passed for feeding purposes or the time fixed for gastrostomy." But when the patient is becoming restricted to liquids, a tube should be introduced, or failing this, a gastrostomy performed. When the patient is fed by enemata only, and merely takes ice by the mouth, it is too late to operate. ii. Amount of pain felt with and difficulty in passing bougies or tubes.—Any sensation of a rough, raw surface, any blood or broken-down tissue on the bougie, increased expectoration, dyspnoea, paroxysmal cough (this may occur after even a teaspoonful of fluids), factor of sputum or bougie, make it evident that the passage of instruments causes advance of ulceration and sloughing; when this is increasingly accompanied with pain and evidence of laryngeal irritation, gastrostomy should be proposed. iii. Site of stricture.—The lower down this is, the more difficulty will there usually be in dealing with it by dilatation, and the nearer are important parts. iv. Condition of patient.—Here the rate of emaciation must be watched; anything like loss of one to two pounds a week is very ominous. How far is the strength preserved? how far does the patient tend to give up his life-habits?

how far is he bedridden? Where the pulse is thready, the extremities cold, the temperature never up to normal, the case has gone too far. v. Condition of viscera.—Evidence of implication of trachea or bronchi, of pleuritic effusion, and of broncho-pneumonia must be sought for. Phthisis sometimes develops or is reawakened in these patients, and is very apt to be overlooked on account of the masking of the symptoms by the disease of the œsophagus. If there is reason to believe that the growth has extended beyond the œsophagus, operation should usually be declined. vi. Rank of life.—A patient who can afford all the luxuries of life, and who can have everything done to palliate his condition, is obviously in a very different condition from one in a humbler position.

I would thus sum up this question of gastrostomy or tubage :—As long as a patient can swallow sufficient food by this means, treatment by tubes is far preferable. Whenever they can be introduced, the tubes ingeniously devised by Mr. Symonds* are to be preferred. These have a funnel-shaped extremity resting on the upper end of the stricture, are introduced on a whalebone guide, and are kept *in situ* by a loop of silk which is passed round the ear. They have the great advantage of allowing the patient to swallow his saliva and food, and thus retain the pleasures of taste. These tubes may be retained in position for months; in one case under the care of Mr. Symonds the tube was worn unchanged for thirteen months. If the silk break, great trouble may accompany the removal of the tube, but this rarely occurs when the silk is protected by rubber tubing.

In one patient, who bit through the silk, the latter blocked the narrow part of the lumen of the tube. Prolonged attempts to withdraw the tube were of no avail, until, at the patient's suggestion, another Symonds' tube was introduced into the original one. The introducer was withdrawn and traction made on the string of the second tube; this was at once successful, the tubes keeping together by suction.

Except for certain short strictures situated from ten to fourteen inches from the teeth, Mr. Symonds now uses his long rubber tube, which may last for about nine months. It should never be removed for cleansing purposes, on account of the difficulty of replacing it, unless this is attempted at once. Saliva cannot be swallowed, as a rule, when this tube is in. The tube should not be passed when the patient is under an anæsthetic, for it may enter the larynx and trachea when the former is insensitive, and this has been attended with disastrous consequences.

Any surgeon treating cancerous stricture here by tubage must remember that treatment of cancer in this way is contrary to what is generally practised, and is only justifiable here on special grounds—*e.g.*, the fatality of the disease and the risks of gastrostomy; that these risks have been enormously increased by the way in which this

* *Clin. Soc. Trans.*, vols. xviii. p. 155, xxii. p. 306; *Brit. Med. Journ.*, April 23, 1887. See also Dr. Rodman's two cases, *Brit. Med. Journ.*, May 25, 1889. It is clear from these cases that the patients can be kept alive as long and gain weight equally by tubage as by gastrostomy, and that in some cases even a malignant stricture can be dilated. On the other hand, the passage of tubes, where there is considerable narrowing, clearly requires some force, and thus needs skilled and very careful hands. Even in such hands, fatal mischief has been inflicted. Furthermore, the blocking of the smaller tubes, which alone will pass in the later stages through tight and ulcerating strictures, may necessitate frequent changing, irritation, and thus hasten sloughing of the growth. The close contiguity of this to the trachea, pleuræ, &c., must not be forgotten.

operation has been deferred; that in these cases a time may come when tubes can no longer be made use of; and that if gastrostomy has been deferred till now, it can only be performed with greatly increased risk. In other words, the patient should understand that if he shuns the risks of an early operation, he renders himself liable to other, but as serious, risks by deferring it till an hour when he can only ask for it, and the surgeon only attempt it, as an almost utterly forlorn hope.

The question of which gives the greatest comfort cannot be answered dogmatically. But no one who has seen many cases of gastrostomy, and met with a fair proportion of success, will hesitate to prefer the result of this, if performed early, with its gain of weight and freedom from pain and irritation during the few months which in any case remain, to the passage of tubes necessarily more and more frequent and difficult as the case progresses, with the not infrequent distress and choking when they are introduced, the blockage of the hollow ones by sputum or food, and the needful withdrawal and reintroduction, easily effected, no doubt, for some time, but ever irritating and fretting the growth.

Mr. Symonds (*loc. supra cit.*) summarises his views upon the subject as follows:—

“1. In cricoid obstruction the long rubber tube gives excellent results. When not well borne gastrostomy, if selected, should be performed early. 2. In disease of the central portion the short tube is serviceable in a fair number of cases, and when it acts well is superior to any other method. It must be replaced by the long feeding tube when pulmonary symptoms arise. 3. In disease of the cardiac orifice tubage is so uncertain that gastrostomy should be performed when dysphagia becomes serious.”

I have performed gastrostomy twelve times, in each case for cancer of the œsophagus: in six patients the operation was asked for too late; in one, my seventh case, the patient died from an accident for which I am responsible; the other five recovered well. One, a young married woman, had had symptoms six months; she was in the fourth month of pregnancy when operated on: she lived in comfort for six months, and died of extension to the lung a month after giving birth to a child at the full time. Another patient lived between three and four months, and would have survived longer if it had not been for his carelessness as to exposure. A third was alive and progressing satisfactorily when last heard of, four months after the operation. The fourth is still alive, four months after his operation. The fifth made a good recovery, but I lost sight of the case nine weeks after the operation.

Robson and Moynihan (*Diseases of the Stomach*, 1904) state that three deaths occurred in nine gastrostomies performed before 1896, and only three deaths in thirty-four of these operations since 1896.

T. P. Legg (*Lancet*, vol. i. 1905, p. 174), in fifteen gastrostomies for cancer of the œsophagus, had three deaths within a fortnight of the operation; nine survived for periods varying from six weeks to seven months, and two of these were still living when Mr. Legg wrote his paper; they had survived for six weeks and five months respectively.

Operation (Figs. 163—171).—Those precautions being taken against shock, such as warm wraps, hot-water bed, table, or bottles, ether is given if the condition of the lungs admits of it, and if it is quietly taken without troublesome, heaving breathing. The surgeon will

usually find it most convenient to stand on the right side and to have his patient drawn over to this side of the table. The shoulders should be somewhat raised and the hips slightly flexed, to relax as much as possible the tension of the soft parts, which often fall with embarrassing sharpness over the epigastric angle from the prominent ribs down to the wasted, retracted umbilical region (Fig. 163).

Sir Henry Howse (*Dict. Pract. Surg.*, p. 590) recommends the following incisions: (1) An oblique one, about two inches and a half long, parallel with and about one inch below the lower margin of the left costal cartilages. This incision should start about an inch and a half from the middle line, and its length must depend on the varying development of the rectus muscle. It should not go higher than the above point, as it will not leave enough free skin and muscle between the cartilages and the incision to fasten the sutures to. This first incision is only to be carried through the skin and fascia. When made, the sheath of the rectus will be seen at the inner end, and at its outer end a portion of the linea semilunaris and of the external oblique. The usual plan of continuing the operation is to have the muscles and fasciæ of the abdomen incised in the same way as the superficial parts. Howse prefers to continue the operation as follows:

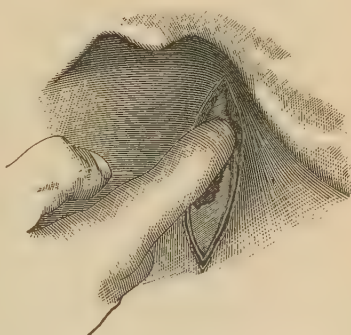
(2) The lips of the wound being separated towards the inner part as widely as possible by retractors, a vertical incision is made in the sheath of the rectus a little distance from its outer margin. The vertical fibres of this muscle will then be seen, and these should be separated, not cut, with a steel director, and the posterior part of the sheath exposed. This may then be incised vertically.

From my experience of 12 cases I prefer, as simpler, a single vertical incision (Fig. 163) beginning opposite to the end of the eighth intercostal space and passing down for two inches over the rectus—i.e., about two inches from the linea alba. The fibres of the rectus, being exposed, are separated with a steel director, or the muscle may be drawn well outwards. The posterior layer of the rectus sheath and the peritonæum are divided together, the incision being about an inch and a half long. A finger is now introduced (Fig. 163) to feel for the stomach.

As a rule, the contracted stomach lies high up under the left lobe of the liver, and requires to be hooked downwards and forwards into the wound. Not infrequently the great omentum presents first, and it is easy, by seeking too low down, to draw up the colon. In case of difficulty the best plan is to find the anterior border of the liver, trace up the under-surface to the portal fissure, and thence along the lesser omentum to the stomach. This is told by its thicker, more substantial feel, and pink-red colour.

The stomach being drawn up, a part is chosen on its anterior surface, free from vessels, and as near as possible to the cardiac end.

FIG. 163.



The finger searching for the stomach through a vertical incision.

A number of different methods of completing the operation have been devised, the object being to produce a valvular opening into the stomach and thus prevent constant leakage and its attendant troubles. The methods described below are the most satisfactory, and each of them has strong supporters, the advantages claimed being the formation of a satisfactory valve and the absence of leakage. Dr. Dennis (*Ann. of Surg.*, November, 1899, p. 633) describes a very satisfactory result in a case of cicatricial stenosis of the œsophagus, operated upon by Marwedel's method two years previously. The man could remove and insert the tube without any trouble, and there was no leakage when the tube was out.

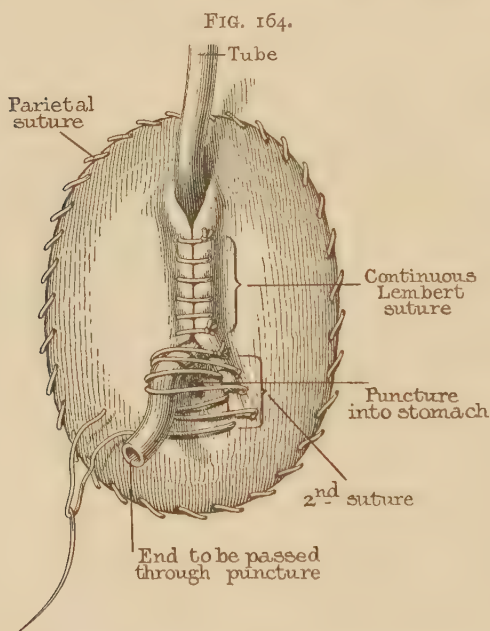


FIG. 165.



Witel's method of gastrostomy. Lembert's sutures are placed in the walls of the stomach before the perforation is made. When the lower suture is tightened the tube and the aperture are buried by two sero-muscular folds. (Modified from Kocher.)

Witel's method of gastrostomy. The two sutures have been tied.

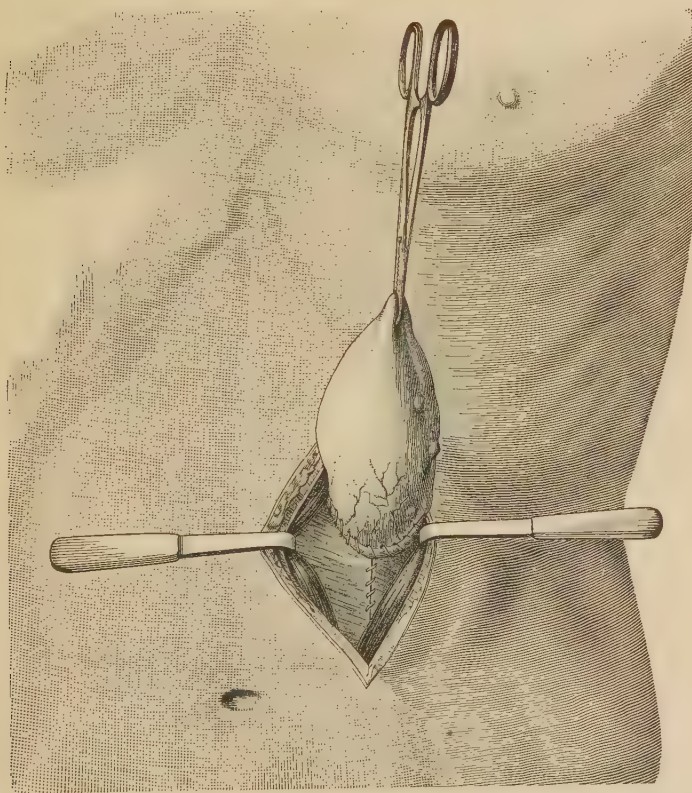
The results obtained by the methods of Albert and Ssabanijew-Frank are very satisfactory, these methods having, moreover, the great advantage of being extremely simple and quickly performed.

i. WITEL'S* METHOD (Figs. 164 and 165).—The peritonæum is opened either by the incision parallel to the left border of the ribs or, as I prefer (p. 449), by one through the rectus muscle. The stomach having been drawn out, a very small opening is made near its cardiac end, and a snugly-fitting rubber tube introduced, and then buried in the wall of the stomach for about two inches by Lembert's sutures,

* *Centr. f. Chir.*, 1891, p. 601. An interesting account of this method is given by Dr. W. Meyer (*Ann. of Surg.*, vol. i. 1893, p. 592). Witel gives two successful cases. Dr. Meyer quotes Mikulicz as having operated five times successfully, and as recommending Witel's method as the best.

two folds of the stomach wall being stitched over the tube, as seen in Figs. 164 and 165. A continuous Lembert stitch is simpler, quicker, and just as good as interrupted sutures. The free end of the tube is then brought out of the wound, while the area around it is stitched carefully to the peritonæum on either side of the wound in the parietes. It is far easier and safer to fix the stomach to the parietal peritonæum and rectus sheath before the opening is made into it (*vide* Fig. 164); and the tube can also be almost completely buried before the perforation is made, the lower end of the tube introduced through this, and

FIG. 166.



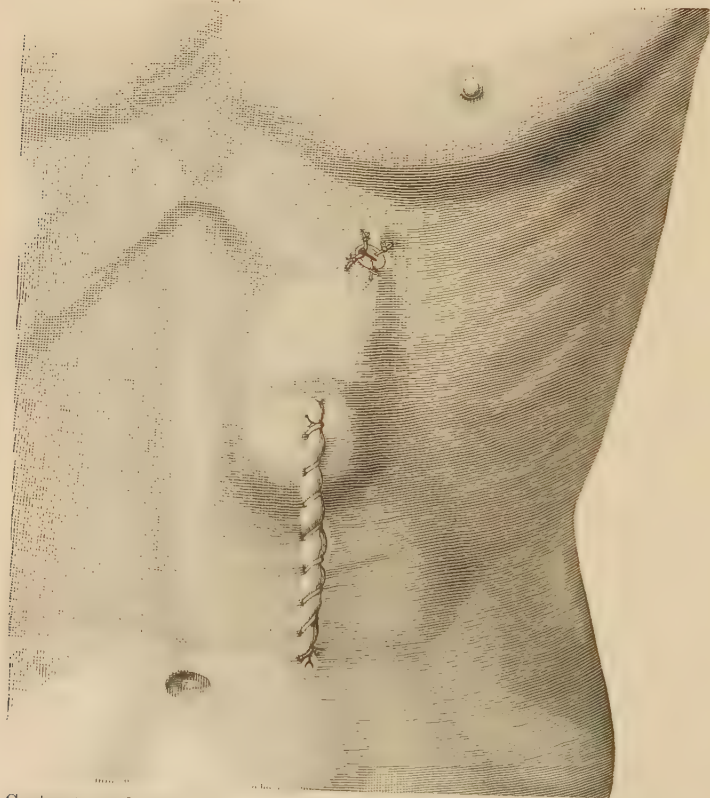
Frank's method of gastrostomy. The stomach is drawn upwards, while below the peritonæum and deeper layer of the sheath of the rectus have been stitched to it by a continuous suture. Retractors hold the fibres of the rectus apart. (Kocher.)

another suture is used to bury the site of penetration of the stomach. The edges of the wound having been sutured, the upper end of the tube may be closed with a clip, and a sealed dressing applied. Feeding by the stomach is begun at once. Any leakage is prevented, not only by this oblique entrance of the tube into the stomach, but, as shown by a specimen obtained from a patient of Dr. Meyer (*loc. supra cit.*), by the fact that Witzel's ingenious method of stitching the stomach walls over the tube causes a short artificial cone to protrude obliquely

into the lumen of the stomach.* Mikulicz and Helferich have shown that, after the lapse of a few months, the oblique passage may become a direct one.

ii. METHOD OF FRANK (Albert, Ssabanijews-Frank).—The peritonæum is opened either by an incision parallel with the costal cartilages, or by one just within the linea semilunaris high up. The stomach having been drawn out, a long conical diverticulum of the anterior wall of the viscus is pulled well out of the wound, and the parietal peritonæum

FIG. 167.



Gastrostomy by Frank's method completed. Below is seen the chief wound closed by a continuous suture. Above is the small wound through which the stomach has been opened. (Kocher.)

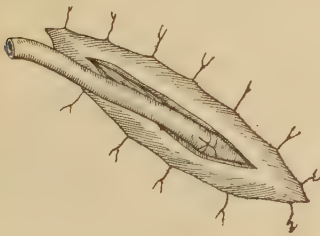
and the posterior layer of the sheath of the rectus are sutured round its base, care being taken not to constrict it too much (Fig. 166). A continuous suture is used, and every care taken not to perforate the mucous coat of the stomach. A small transverse incision is now made through the skin a little above the front and on the level of the costal cartilages. The skin between the two openings having been separated

* Another advantage of Witzel's method is illustrated by one of his cases. In a patient who had been operated upon for cicatricial stricture of the cesophagus, the fistula closed spontaneously within sixteen days after the stricture had been dilated and the tube removed from the stomach (Meyer).

from the subjacent parts, the diverticulum of the stomach is drawn up under the skin and over the costal cartilages as far as the small skin incision, to the edges of which its apex is united by a few sutures. A small opening is next made here into the stomach, and the orifice fixed to the skin by one or two points of suture (Fig. 167). The lower part of the wound is then closed by a continuous suture. As a result the diverticulum of the stomach is drawn upwards, its base is gripped by the muscular fibres of the rectus, while a short upward-directed subcutaneous œsophagus is also formed. All escape of fluid is thus prevented, and the patient can be safely fed at once.

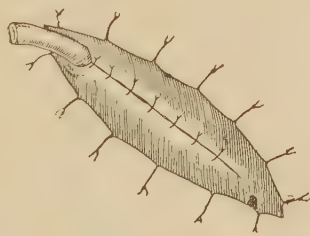
Kocher (*Operative Surgery*, 1903, p. 194) uses and recommends a combination of the methods of Frank and Witzel, on account of the difficulty of getting a long enough cone to form a valvular fistula by Frank's method alone. The rectus muscle is exposed and pulled well outwards, and a pouch of stomach is fixed to the parietes as in Frank's operation. Then a rubber tube is inserted and buried after Witzel's method, and, lastly, the stomach wall around the exit of the tube is sutured to the skin to prevent any chance leakage into the wound.

FIG. 168.



Gastrostomy by Marwedel's method,
First stage.

FIG. 169.



Gastrostomy by Marwedel's method.
Second stage.

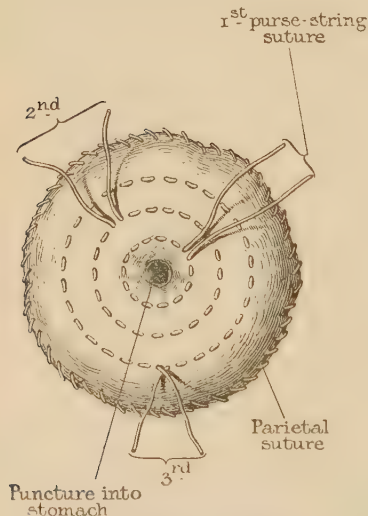
The rectus muscle, by its tension, helps to prevent the fistula leaking. At an autopsy it was discovered that the opening in the stomach was small and drawn in; "it was connected with the opening in the skin by a canal one and three-quarter inches long, which had no mucous lining and was perfectly smooth."

Mr. T. P. Legg (*Lancet*, 1905, vol. i. p. 1711) draws out a cone of stomach two and a half inches long if possible, and pulls this for one and a half inches to left through the rectus muscle, the fibres of which have been separated into anterior and posterior bundles. The base of the cone is fixed on its right border by about five stitches to the posterior wall of the rectus sheath and peritonæum, and near its extremity it is secured by four sero-muscular suture to the rectus sheath, and to the skin wound, which is an inch long and is parallel to the rectus muscle fibres and the original wound. The latter is closed by means of salmon gut sutures, which include the anterior layer of the rectus sheath, and some of the fibres of the muscle. A sealed dressing is applied to the wound. It is claimed that this operation provides a better sphincter for the fistula, owing to the greater length of cone which is surrounded by muscle fibres. In only one of the fifteen patients operated upon by Mr. Legg was there any leakage, and this only lasted a month, and was probably due to the sloughing out of some of the stitches which occurred.

iii. MARWEDEL'S METHOD (Figs. 168 and 169).—The stomach is exposed and attached to the abdominal incision by a continuous suture. The serous and muscular coats are then incised vertically to the extent of about two inches, and dissected from the mucous membrane on either side. A small incision is then made through the mucosa at the lower end of the incision, and a rubber tube introduced and fixed by a suture. The tube is then laid vertically along the mucous membrane, and the incision in the serous and muscular coats closed over it as shown in Fig. 169. An oblique valvular aperture is thus produced.

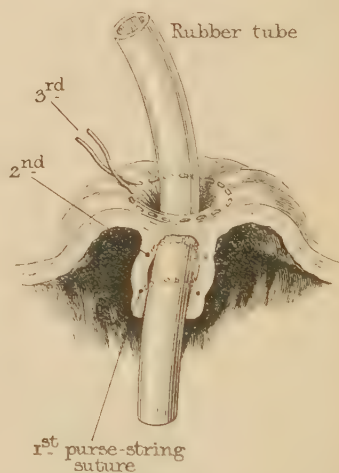
iv. ABBE'S MODIFICATION OF KADER'S METHOD (*Ann. of Surg.*, January, 1899, p. 113).—Here a circular valve is formed in the following manner:—Through the abdominal incision a conical portion of the wall of the stomach is withdrawn, and its edges sutured to the parietal

FIG. 170.



Abbe's modification of Kader's method of gastrostomy. Purse-string and parietal sutures placed. The area of stomach exposed should be elliptical in a vertical direction.

FIG. 171.



Abbe's modification of Kader's method of gastrostomy. Section showing the effect of tying the purse-string sutures.

peritonæum. Two, or even three, concentric purse-string sutures are then passed circularly round the protruding cone. A small incision is now made at the apex of the cone, through which a tube is passed. The nearest purse-string suture is now drawn tight round the tube, and the latter then pushed inwards till the next suture comes into contact with it, when it is also drawn tight. In the same manner the third suture is drawn round the tube after further inversion. The external wound is then closed. Feeding through the tube is commenced at once. After a week or ten days the tube becomes loosened, and is then only passed at meal-times. The inverted cone here forms a circular valve which effectually prevents regurgitation. This was so in each of six cases described by Dr. Abbe, and in one case, in which death took place from hæmorrhage from the growth four days after operation, there was not the slightest leakage when the valve was tested by hydraulic pressure.

v. DEPAGE'S METHOD (*Journ.-de-Chir.*, November and December, 1901).

—A part of the anterior wall of the stomach is fixed to the edges of the parietal peritonæum by means of a continuous suture, and a portion of this is picked up and clamped. A tongue-shaped flap is cut with its base upwards, and its lower edge is drawn up, so that a long elliptical wound is formed. The edges of this are sutured in two layers, one continuous suture uniting the mucous membrane and the other inverting the serous coat.

The tube thus formed is sewn to the edges of the parietal wound, or if long enough it may be drawn obliquely through the parietes to a small incision near the xiphoid cartilage. This operation is not so simple as those already described, and should not be chosen when it is possible to draw a cone of the stomach itself to form a tube, and I prefer Abbe's modification of Kader's operation or Witzel's operation even in cases of contracted stomach, for these operations are easier to perform, and accompanied with less risk of hæmorrhage and leakage in these marasmic patients.

For the first few days milk and brandy, just warmed, and peptonised if preferred, should be the chief food, given with the yolks of one or two eggs. A little later beef-tea, soups, well-pulped vegetables, with plenty of fluid, should be given. In Sir Henry Howse's words, "when the larger sizes of tubes have been introduced, solid food may be poured into the stomach by the aid of a large wide-mouthed syringe. This food should be minced meat, with a certain proportion of vegetables, all finely ground in the mincing machine."

Patients are often very ingenious in feeding themselves. Some, to enjoy the taste of food, have masticated solids and then passed them through the fistula.*

If the operation has been deferred till too late, and it is absolutely needful to feed the patient at once, the best method will probably be either Frank's or Kader's. If the opening is deferred, a small amount of liquid may be introduced every few hours through one of the large hypodermic syringes made for exploration, and holding a drachm or two. The puncture must be repeated at each occasion of feeding, obviously a risky proceeding.

Dilatation of Strictures of the Œsophagus from below through an Opening in the Stomach.—Where non-malignant strictures low down in the œsophagus resist dilatation from above, and the patient is losing ground, the stricture may be attacked from below in one of the following ways:—

(i.) **By Gastrotomy**, the opening being closed at the same time. Prof. Loreta, of Bologna, operated on the first case in 1885.†

The patient, aged 24, had swallowed caustic alkali. Attempts to dilate the stricture by bougies were unsuccessful, and at last it became impossible to pass any instrument. The point at which the sound was arrested seemed to correspond with the fourth dorsal vertebra. The patient was entirely unable to swallow, and emaciation had

* Thus, Mr. Durham (*Syst. of Surg.*, vol. i. p. 803; *Lond. Med. Rec.*, March, 1878) mentions a patient of Trendelenburg's who, after masticating his food, spat it into a funnel, and then forced it on through a tube into his stomach. Two of my later patients have fed themselves after this fashion through a tube.

† An excellent summary of Prof. Loreta's cases is given by Mr. Holmes (*Brit. Med. Journ.*, Feb. 21, 1885).

become extreme. Eleven months after the injury an incision about five inches long was made from the xiphoid cartilage downwards and to the left. Some difficulty was met with in finding the stomach, owing to its contraction and the way in which the liver overlapped it; but at length the operator succeeded in drawing the greater part of the stomach out of the wound, and a longitudinal incision was made through its walls between the two curvatures, having its upper end as near the cardia as possible. The next step was to find the orifice of the œsophagus, in order to introduce the dilator; but this involved considerable difficulty,* and the search was interrupted by a considerable quantity of bile, which regurgitated from the duodenum into the stomach. At length, by searching with the left index between the under-surface of the liver and the small curvature of the stomach, the end of the œsophagus was found. Then the distended stomach was kept drawn down by an assistant while the operator introduced a dilator (something like that of Dupuytren for lithotomy). The wound was then sewn up and the stomach returned. The patient rallied well, and in six hours swallowed some soup, with the yolk of an egg, to his great joy, as for twelve months he had been unable to do more than swallow mouthfuls. Recovery is stated to have been complete.

Mr. Kendal Franks has related an instructive case of the same kind (*Ann. of Surg.*, vol. i. 1894, p. 385):—

Here the whole of the right hand was introduced into the abdomen, and the index finger into the stomach through an opening an inch long situated about midway between the curvatures and the orifices. As the finger could only just reach but not dilate the stricture, an Otis's dilating urethrotome (the blade having been removed) was guided by the finger into the stricture, screwed up, and withdrawn fully expanded. After this had been done both laterally and antero-posteriorly, an œsophagus bougie could be easily passed through the stricture from above. The wound in the stomach was united with two continuous sutures, one uniting the mucous membrane, the other, by Lembert's method, the peritonæal coat. The patient made a good recovery. Large-sized bougies could be passed without difficulty or pain.

It is clear that the above method may be resorted to with great benefit in non-malignant strictures low down in the œsophagus, where the dilated condition above the contraction makes it very difficult to hit this off with a bougie.

(ii.) **By Gastrostomy.**—This, while rendering manipulations safer in a measure, cripples the surgeon's movements, as it will be impossible, however much the fistula be dilated, to get the finger passed through it anywhere near the stricture in the œsophagus.

Instrumental dilatation can alone be made use of through a gastric fistula, and for this reason the method by two stages is inferior to the other. It has been most ingeniously used under the following circumstances:—

In 1889, Hagenbach (*Correspondenzblatt Schweizer Aerzte*, No. 5) directed a patient with a non-malignant stricture of the œsophagus to swallow a small shot attached to a long thread. This was drawn out of the stomach through the fistula, and a strong silk thread fastened to it and drawn up through the mouth. To the lower end a bougie was tied, and increasing sizes were daily drawn through the fistula.

Dr. R. Abbe, of Newport (*Ann. of Surg.*, vol. i. 1893, p. 489), advises what he calls the "string" method in the treatment of dense fibrous strictures. A gastrostomy having been previously performed,† a small

* See the directions given at p. 459.

† In this and the preceding instance the gastrostomy opening should be placed as high up as possible. In his case Dr. Abbe opened the œsophagus near the root of the neck as well as performing a gastrostomy.

gum-elastic bougie is guided through the stricture from below up into the mouth, and a stout silk ligature passed in the same way. This silk being see-sawed backwards and forwards, the stricture is felt to yield, and larger bougies can then be passed.

Dr. Dunham (*Ann. of Surg.*, vol. xxxvii. 1903) has devised a simple and ingenious way of getting a thread through a stricture of the œsophagus. He uses "an ordinary drinking tube, a glass of water, and a piece of black silk thread. The tube is threaded so that one end of the thread is at the mouth end of the tube. The patient then drinks through the tube. The thread is carried up the tube and on into the œsophagus by the current of water. More thread is fed into the water as it disappears up the tube, care always being taken that it is not fed in too rapidly. When several feet of thread have been thus washed down the lower portion of the thread may be fished out of the stomach by means of a bent probe, passed in at the gastrostomy opening." In some cases this method may fail from want of co-operation on the part of the patient, and the thread may then be introduced through a funnel and rubber tube, the latter being passed into the pharynx or œsophagus. Once the thread has been introduced, larger ones will follow, and these can be used as suggested by Abbe. Soon rubber tubing, kept upon the stretch by traction upon a string attached to each end of it, can be introduced, as suggested by Curtis (*Ann. of Surg.*, vol. xxxi. p. 358). This effects dilatation very rapidly, and larger ones can be introduced until biconical French bougies can be used with ease, and the gastrostomy wound closed.

Dr. Dowd (*Ann. of Surg.*, vol. xxxix. 1904, p. 272) records a very interesting and successful case of simple stricture near the cardiac end of the œsophagus, which was impermeable from above, and also from the stomach. Dunham's method of introducing a thread was tried, and failed. Kelly's cystoscope tube was used to locate the cardiac orifice from below, and to conduct bougies to the orifice, but the bougies would not pass. Dunham's plan was tried again, and proved successful. The stricture was dilated by the methods of Abbe and Carter, and within two months large (No. 28) bougies could be passed with ease, and ordinary food partaken of. The gastrostomy wound had been dilated for the introduction of the cystoscope, and leakage therefore occurred, so that it became necessary to close the fistula by an operation.

Difficulties in and after Gastrostomy.

i. The very prominent angle formed between the ribs and the sunken umbilical region (p. 449). ii. Hæmorrhage. This will be almost *nil* if the rectus fibres are separated with a director, and the veins on the stomach carefully avoided. iii. Finding the stomach. iv. Drawing this up into the wound if itself affected by disease, as when the primary disease is situated very low down in the œsophagus, or if it is adherent by reason of secondary deposits. v. Jerking breathing due to the anæsthetic. vi. Completing the second stage of the operation. vii. Intense pain on introducing food into the stomach.

In a patient of Mr. Butlin's (*Brit. Med. Journ.*, April 14, 1883) this was found to be the case, the patient dying nearly a month after the operation. Mr. Butlin attributes this pain to his opening having been close to the pylorus.

If it is thought that the opening is made too near either extremity of the stomach, it would be well after feeding to keep the patient turned on to the opposite side. viii. Leakage of gastric juice and regurgitation of food. This is an extremely troublesome complication, leading, as it does, to most rebellious dermatitis; it is fortunately quite rare with modern methods.

Causes of Death after Gastrostomy.

i. Inanition and exhaustion, the operation being performed too

late. 2. Peritonitis. 3. Extension of the disease to surrounding parts—*e.g.*, trachea, bronchi, &c. 4. Lung affections—*e.g.*, pneumonia, due in part to the operation viz., the anæsthetic and enforced recumbency—and in part possibly to the saliva, which cannot pass down the œsophagus, being drawn into the air-passages, either before or during the operation. 5. Hæmorrhage—*e.g.*, from ulceration into aorta or lung. 6. Acute gastritis. 7. Suppuration between stomach and liver. 8. Phthisis.

GASTROTOMY.

Indications.—The operation may be required for the removal of foreign bodies which will not pass through the pylorus, such, for instance, as forks, as in MM. Labbé's and Peau's cases, and masses of hair, as in Thornton's (*Lancet*, Jan. 9, 1886) patient. Increasing pain, vomiting, emaciation, and sufficient time having elapsed to allow of the body passing, will be the chief indications. In a very few cases gastrotomy will be required also for the removal of foreign bodies impacted low down in the œsophagus. It is also indicated in certain cases of severe gastric hæmorrhage, and for the dilatation of fibrous strictures of the œsophagus (*vide supra*, p. 455).

Operation.—A. FOR REMOVAL OF FOREIGN BODIES FROM THE STOMACH.—Such cases as Mr. Thornton's show that this operation can be safely performed at one stage.

The parts being cleansed and the abdomen relaxed, one of the following incisions is made :—(1) Over the body itself, when this can be felt. (2) In the case of a large body, through the left rectus sheath or in some cases through the right. (3) One of the incisions given for gastrotomy—*e.g.*, one parallel with the left costal margin and about an inch below it, reaching from a point near the xiphoid cartilage obliquely downwards and outwards to a point opposite to the ninth rib. One of the first two will probably be the best. The abdominal wall having been divided, and the peritonæum opened, the exact site of the foreign body is made out. If this be pointed, great care must be taken not to let it damage the stomach during the needful manipulations. In such cases the external opening must be free, that the surgeon may see what he is about. In the case of such a body as a fork the blunt end must first be found.

When the surgeon has decided where to open the stomach, he brings this part out of the wound and packs sterile gauze all around it, so as to steady it, and also to shut off the peritonæal sac.

The stomach is now opened with scissors by an incision transverse to its long axis, and of length adapted to the case. As far as possible, any vessels must be avoided, but any that bleed will at once be commanded by Spencer Wells's forceps. The body is next extracted with suitable forceps or a scoop, care being now taken not to damage the stomach, especially if the foreign body has set up inflammation or ulceration, and to allow no blood or mucus to escape into the peritonæal sac.

After the removal of the foreign body, if the stomach contains much mucus or blood, this may be removed by gentle sponging. The

aperture in the stomach is then closed with a continuous suture which pierces all the coats, care being taken not to evert the mucous membrane. This is reinforced by a continuous Lembert suture. The parietal wound is closed.

B. FOR REMOVAL OF BODIES—*e.g.*, TOOTH-PLATES—IMPACTED IN THE LOWER PART OF THE ŒSOPHAGUS.—These cases, though rare, are so difficult as to call for some remarks here. Prof. Richardson, of Harvard University, first brought forward a very successful case of this operation (*Lancet*, 1887, vol. ii. p. 707). A plate carrying four teeth had been impacted eleven months in a patient aged 37. Numerous attempts had been made to remove it from the mouth. The plate was successfully removed by gastrotomy, by an incision six inches long parallel to the lower margin of the left ribs. The following interesting details are given:—

Determination of the Site of the Foreign Body.—In an individual of average height, and with a neck of ordinary length, the distance from the incisors to the diaphragm is fourteen and a half inches. All parts of the œsophagus are accessible to the finger either by gastrotomy or external œsophagotomy. With the right forefinger introduced by œsophagotomy and the left by gastrotomy it was found possible, not only to make the fingers touch, but in many cases overlap. But these results are only approximate, as it would not always be possible to do both operations on a patient. It is possible to reach with the left hand three inches above the cardiac opening—*i.e.*, the length of the left middle finger. From above, through the wound in the neck, one cannot reach quite so far on account of the sternum and clavicle. Allowing in the average neck one and a half to two inches from the cricoid cartilage to the lowest point of the wound in the œsophagus, we have the average distance from that incision to the cardiac opening of five and a half or six inches. If the obstruction be less than six inches from the cricoid, an attempt should be made to remove it from above; * if more than this, or thirteen inches from the teeth, gastrotomy should be performed. The incision that, on the whole, is recommended is an oblique one below the margin of the left ribs. The stomach being drawn up into the wound, it is most essential to put the lesser curvature on the stretch, so that it makes a straight line to the diaphragmatic opening. The cut through the stomach wall must be far enough to the right to allow the passage of instruments along the sulcus between the anterior and posterior walls of the stomach, made tense as above. If the instrument is brought obliquely to this groove and passed upwards, all the time being pressed gently against the straightened lesser curvature, it will glide into the œsophagus every time with the greatest ease. The opening in the stomach should be first large enough to admit instruments; if these fail, it must be enlarged, and the whole hand introduced.

In the following case I was much less fortunate, owing to the way in which the tooth-plate was jammed above the cardiac orifice. While

Mr. Fullerton (*Brit. Med. Journ.*, May 7, 1904) performed œsophagotomy and removed a halfpenny which had been impacted for seven months opposite the third and fourth dorsal vertebræ, and four and a half inches below the wound. The wound was closed by deep and superficial sutures of catgut, and the child, æt. 7, recovered.

such cases are rare, they are most important, on account of the numerous difficulties which they present.

E. W., aged 44, was sent to me at Guy's in May, 1889, having swallowed a vulcanite tooth-plate, which "stuck in his throat." The plate originally carried seven, but now only two teeth. A medical man whom he saw at once pushed the plate down with a bougie. An emetic which had been given then acted and brought up some blood. The patient complained of constant pain in the epigastric region just below the xiphoid cartilage, and in his dorsal vertebræ. Swallowing was painful, and so was eructation of gas, though this gave relief. Patient was able to swallow food quite well. He was not troubled by vomiting. A bougie could be passed into the stomach, but just before it entered it rubbed over a foreign body. The body did not yield in the least to any force which I thought it justifiable to use with the bougie. On June 11 I operated as follows: The stomach having been washed out with dilute boracic acid, an incision three inches and a half long was made, parallel with the linea alba, commencing on the level of the xiphoid, and about an inch to the left of it. The rectus, the sheath being opened, was split with a steel director. The stomach was very small and pale. Sponges having been packed around, it was opened, with scissors, just to the right of the cardiac end, and as high up as possible. The opening was about a quarter of an inch long. Three small vessels sprang, and were tied. The exploring finger detected the body imbedded just above the cardiac orifice. The mucous membrane around felt pulpy and swollen. Numerous curved forceps were introduced by the opening, and then along the lesser curvature, but, though the body was repeatedly seized, I was quite unable even to loosen it. This was due to its not presenting any projecting points and to the swelling of the mucous membrane around. I next enlarged the opening in the stomach so as to introduce my hand, but, though with the tip of the middle finger I was able to reach the plate, I was unable to dislodge it. Mr. Durham and Mr. Davies-Colley also tried, with a like result. Moreover, to steady it, Mr. Tubby was good enough to keep the end of an œsophageal bougie pressed against it from above. I closed the lower two-thirds of the wound in the stomach with Lembert's sutures of fine silk, and stitched the remaining part to the upper part of the parietal incision, so that other forceps might be tried later on. The patient, however, never rallied completely, and sank about forty-eight hours afterwards. At the post-mortem examination the coronary arteries were found in an advanced stage of atheroma. There was no peritonitis or escape of gastric contents. The mucous membrane near the cardiac orifice of the stomach presented a ragged appearance dating to the prolonged manipulations. The plate was very firmly fixed in the œsophagus, one inch and a half above the cardiac opening.

M. Bluysen (*Lancet*, 1906, vol. i. p. 192) performed gastrotomy and removed a denture which had been swallowed a fortnight earlier, and had become impacted near the cardiac orifice. Forceps having failed, the index finger was introduced into the lower end of the œsophagus, and served to hook and remove the plate.

C. FOR CERTAIN CASES OF SEVERE AND RECURRENT HÆMORRHAGE FROM A GASTRIC ULCER.—A considerable number of these cases have been operated on with a fair amount of success, although the exact indications for operation and the best methods of dealing with the bleeding cannot be said to be finally settled.

It is not easy to estimate the percentage of deaths that occur from hæmorrhage in cases of gastric ulcer under medical treatment, for the fatalities will vary almost inversely with the duration and thoroughness of the medical treatment, which should always be tried.

Mayo Robson, and Moynihan in their work on *The Diseases of the Stomach* (1904) conclude from published records that the mortality from hæmorrhage may vary from 3 to 11 per cent. Dr. Bulstrode (*Clin. Soc. Trans.*, 1903, p. 86) collected the records of the 500 cases of gastric ulcer which were admitted into the London Hospital between

1897 and 1903. He found that 2·5 per cent. of these patients died from hæmorrhage, 10 per cent. from perforation peritonitis, and altogether 18 per cent. of the patients died. In 42 per cent. of the cases, from one to four or more relapses occurred.

Dr. Hawkins and Mr. Nitch (*Royal Med.-Chir. Soc.*, Nov. 13, 1906) found that less than 1 per cent. of 419 consecutive cases of gastric ulcer collected from the records of St. Thomas's Hospital died of bleeding. It is clear that many of these cases relapse, and that not all of these will seek admission again into the same institution, so that the figures are clearly too favourable as they stand. The total mortality of the 556 cases at St. Thomas's Hospital was 13·3 per cent.; 8·5 died from perforation, and 1·9 from sequelæ.

These figures serve to show how efficient medical treatment for bleeding may be if carefully carried out, but unfortunately it is not practicable under existing circumstances to treat the poor subjects of gastric ulcer by rest and dieting for the long time that is necessary for cure. Too often they have to return to work when only beginning to recover, and it is not surprising that relapses are so frequent.

It should be remembered also that a timely operation for the relief of recurrent hæmorrhage may not only arrest the bleeding, but may lead to healing of the ulcer, and prevention of perforation and other complications and sequelæ, which, although they may not always be immediately fatal, yet shorten and spoil many lives.

That hæmorrhage is an important cause of death is shown by the following facts. Dr. Wall (*Clin. Soc. Trans.*, 1903, p. 90) found that of the cases of gastric ulcer with bleeding as a symptom 6 per cent. of the women and 12·5 per cent. of the men over 30 years of age died from hæmorrhage alone. MacNevin and Herrick (quoted by Hale White, *loc. infra cit.*) state that of 55 cases of undoubted gastric ulcer, shown at a post-mortem examination, which died from either perforation or hæmorrhage, 25 died from hæmorrhage. Of these 19 were males and 6 were females, of the 30 dying from peritonitis 8 were males and 22 were females, and of the 25 of both sexes dying from hæmorrhage all except one female were 30 years of age or over 11.

It is rarely, if ever, wise to operate during the occurrence of acute hæmorrhage, for only a few patients die from a single hæmorrhage, and the tendency to a natural arrest of the bleeding is very great in acute ulcers under proper medical treatment, whereas the results of operations which have been performed during the progress of bleeding have been very bad. Mr. Paterson estimates that the mortality of operations performed during hæmorrhage is about 80 per cent., whereas only about 5 per cent. die under medical treatment. The operation will only increase the collapse and profound anæmia, from which the patients may recover without an operation under medical treatment. When large vessels have been opened, death occurs so speedily that an operation is rarely practicable in time to save life even if the bleeding vessel can be found and secured.

Although a few successful operations have been undertaken during recurrent attacks of severe hæmorrhage, there is but little doubt that it is far better to defer surgical interference until the bleeding has

ceased and time has been granted for reaction from collapse to take place.

Dr. Hale White (*Lancet*, 1906, vol. ii. p. 1189) has collected 29 cases of "gastrostaxis," or the oozing of blood from the mucous membrane of the stomach. Only two of these patients were males, and most of them were women well under 40 years of age. Although this disease is rarely fatal under medical treatment, 8 deaths occurred in 24 cases treated by operation, a mortality of 27·5 per cent.

The ulcers which give rise to serious hæmorrhage are usually situated on the posterior wall of the stomach, and nearer to the lesser curvature than the greater. The character of the ulcers is very variable. They may be small and quite superficial, when the bleeding commonly arises from vessels in the submucous layer; or they may be deep and adherent to structures outside the stomach, leading to ulceration of large vessels, such as the aorta, or the hepatic, coronary, splenic, or pancreatico-duodenal arteries. It should also be borne in mind that in a number of cases more than one ulcer or erosion was present, and that in others the ulceration may be in the duodenum, or that no ulcer may be discovered, or even exist. Leube and Kocher give as indications for operation recurrent severe hæmorrhages when careful dieting, rest, and other medical measures have failed. A single profuse bleeding is not necessarily an indication for operation, because a second hæmorrhage may never occur.

Mr. H. J. Paterson, in his Hunterian Lectures (*Lancet*, vol. i. 1906, p. 502), gave the following excellent summary of his views upon this subject:—

"In hæmorrhage from an acute ulcer, erosion, or exulceratio simplex, that is, when the onset of bleeding is sudden and previous history of gastric ulcer is absent, first give a thorough trial to absolute rest in bed, Trippier's hot water injections by the rectum, and avoidance of food by the mouth for at least four or five days. If a second profuse hæmorrhage occurs perform gastro-jejunostomy, provided it is quite clear that the second hæmorrhage has not been brought on by want of absolute rest, by too early stimulation, or by too early administration of food. It is advisable to delay operation until the patient has recovered from the collapse induced by the hæmorrhage. In hæmorrhage from a chronic ulcer, that is in cases with a definite history of pain after food, vomiting, and possibly previous slighter attacks of hæmatemesis, perform gastro-jejunostomy after one severe attack or after several slighter attacks of hæmatemesis if the loss of blood is causing serious anæmia."

With these views I agree in the main, but it is certain that gastro-jejunostomy will not be found to be sufficient in all cases; and it is probable that many cases of subacute gastric ulcer with hæmorrhage will get well without operation, if only the treatment be carried out thoroughly and for a sufficient length of time. When this is impracticable for various reasons, or the hæmorrhage recurs even under careful medical treatment, an operation should be undertaken, although it carries with it a considerable risk. The danger is worth running, especially when the ulcer is at or near the pylorus, for gastro-jejunostomy may provide rest for the stomach, induce the ulcer to heal, and thus prevent troublesome and dangerous complications.

The following are a few of the cases that have been reported; they give some idea of the various means that have been adopted:—

Roux (*Revue de Gynécologie*, 1897, p. 113) reported two successful cases. In the first he ligatured the bleeding vessel and then excised the ulcer; and in the second he ligatured the artery at the two ends of the lesser curvature without removal of the ulcer. Guniard (*Thèse Trognon*, Paris, 1893) performed gastro-enterostomy for a bleeding pyloric ulcer, with recovery. Kuster (*Ann. of Surg.*, August, 1894) cauterised the ulcers in two cases, and in each also performed gastro-enterostomy, with recovery. Korté (*Proceedings of the German Surgical Congress*, 1897) cauterised an ulcer which could not be extirpated, the patient dying eight days later, a perforation of the splenic artery being found at the necropsy. Mikulicz (*Thèse de Marion*, Paris, 1897) reported two cases. In the first he excised the ulcer, and the patient recovered; in the second he used the cautery, the patient dying the same evening. Cazin (*Presse Médicale*, 1899, p. 31) reports a case in which he found four erosions. These were sutured with catgut, and the patient recovered without further hæmorrhage. In a number of cases the operation failed owing to inability to discover the ulcer. Finally, in an exhaustive paper by Drs. Andrews and Eisendrath (*Ann. of Surg.*, October, 1899) from which the greater part of the following is gathered, two brilliantly successful cases operated upon by Dr. Andrews are described, the plan adopted here being ligation of the ulcer *en masse* within the cavity of the stomach.

Mansell Moullin (*Clin. Soc. Trans.*, 1903, p. 85) refers to eleven operations for gastric hæmorrhage, with only two deaths, although six of the patients were so collapsed that infusion had to be resorted to either during or soon after the operation.

One patient died of hæmorrhage, and another of peritonitis, due to leakage from want of union of the gastric incision which was made for exploration.

In two cases silk sutures were used to underrun and compress the ulcers from the mucous surface; in three the ulcer was excised without trespassing on the muscular wall, and the edges of the mucous membrane were sutured. In one a portion of the whole thickness of the stomach wall was removed. The ulcer and all the coats of the stomach were invaginated and ligatured from within in two cases, serous sutures being used to protect the site of the invagination.

Sutures were passed through all the coats from the mucous membrane to include and secure the ulcer. In one case, Lembert sutures being employed to bury the deep stitches, no leak occurred at the ulcer, but fatal peritonitis followed failure of union of the exploratory wound.

In one case a gastric exploration failed to reveal any ulceration, but, after remaining well for a year, the man became suddenly collapsed, and this condition was followed by profuse melæna, probably due to duodenal ulcer. In another case a negative gastrotomy was not followed by any recurrence of hæmorrhage for over two years and a half. Such cases are very exceptional (*Brit. Med. Journ.*, vol. i. 1904, p. 420).

Operation.—The incision must be free, and should in the first instance be median. If this does not give sufficient room, the left rectus may be subsequently divided. The chief difficulty is the finding of the ulcer. The anterior surface and the two curvatures of the stomach should be first systematically examined for any indurated spot; then the posterior surface is reached and examined by passing

the hand through a hole in the great omentum. If no external guide to the position of the ulcer is found in this way, Andrews and Eisendrath recommend the examination of the interior of the stomach through a vertical incision in the anterior wall, this incision being so placed as to avoid as far as possible any large vessels which are visible. Before this incision is made, the stomach must be withdrawn from the abdomen as far as possible, and carefully isolated with sterile gauze. The whole interior of the stomach is then carefully and systematically inspected, a strong electric light being essential. Andrews and Eisendrath carry this out in the following manner:—"The hand is passed behind the organ through the opening in the omentum already mentioned. The posterior wall is now pushed forward into the opening and passed portion by portion into plain view. This may be continued until the whole posterior wall to the cardiac end has been gone over. The greater and lesser curvatures and the remainder of the anterior wall may in the same manner be caused to invert and pass in review beneath the opening, the latter being caused by traction to assume various positions to assist in this invagination. Should the posterior wall be adherent to the pancreas, as in Case I., and somewhat immovable, that particular part of the viscus should be inspected by reflected light. In such a case the lesser peritonæum should be opened, which will give additional access to the posterior wall. We now come to a portion of the stomach interior which cannot be drawn down or forward—namely, the cardiac end, where it is covered by the left lobe of the liver and attached to the diaphragm. To inspect these parts it is necessary to illuminate the cavity, and retract the liver and costal arch. The Trendelenberg position would probably be of assistance at this stage both in gaining access and in the matter of illumination. With care a good view can be obtained of the whole cardiac end and opening." The treatment of the ulcer or ulcers when found must vary according to the conditions present. If the ulcer is quite small and superficial, it should, if possible, be excised without invading the muscular coats, and the edges of the mucous membrane should be sutured. Failing this, the ulcer may be ligatured *en masse*, or under-run with sutures. The cautery has been successfully used in some cases. Excision offers the best chance of healing, but this will not be possible when the base of the ulcer is adherent to parts outside the stomach, and when it is large and situated at the pylorus. Some small pyloric ulcers may be treated by excision, followed by pyloroplasty.

Some deep ulcers unsuitable for excision may be ligatured *en masse*, as Andrews (*loc. supra cit.*), did in his two successful cases, or invaginated and protected by serous sutures, as adopted by Mansell Moullin. Failing these methods, gastro-enterostomy must be performed, and it is improbable that any treatment will be completely and permanently successful without the drainage provided by gastro-enterostomy. It is even probable that this operation should be resorted to at once in the majority of cases without a preliminary and perhaps fruitless exploration of the interior of the stomach.

Mr. Moynihan (*Royal Med.-Chir. Soc.*, Nov. 13, 1906) has operated 33 times for recurrent hæmorrhage from gastric and duodenal ulcers. "Posterior gastro-jejunostomy was performed in every case save one. In this case the ulcer was excised; the patient died. In

21 gastro-jejunostomy was the only treatment adopted; two of these died. Gastro-jejunostomy was combined with excision of the ulcer in two patients, one of whom died. Gastro-jejunostomy with infolding of the ulcer was done eight times, with two deaths. Gastro-jejunostomy with infolding of the pylorus and of the ulcer was performed once; the patient recovered."

Six of these 33 patients died. One of them had cirrhosis of the liver, and no ulcer could be found. One died collapsed at the end of a week, but the cause of death is not known. One died of pneumonia, one of exhaustion after eleven days, another after three weeks. One died from shock a few hours after the operation. It will be noticed that the mortality of the operation has been 8 per cent. in spite of Mr. Moynihan's skill in gastric surgery; but the cases were mostly grave ones, and no recurrence of bleeding took place in any of them. Mr. Moynihan now combines infolding of the ulcer with gastro-jejunostomy, and considers this to be the safest and best procedure.

Paterson (*loc. supra cit.*) recommends gastro-jejunostomy without local treatment of the ulcer in all cases, because he believes the operation to be sufficient, and to be less dangerous than local treatment.

If gastro-jejunostomy could be relied upon to secure the arrest of gastric hæmorrhage, and to prevent its recurrence, gastrotomy would be no longer necessary in these cases.

The direct treatment of the bleeding spot is beset with difficulties for the surgeon and dangers for the patient. The bleeding ulcer may not be in the stomach, but in the duodenum, or it may be difficult or impossible to find the source of bleeding, or the wrong ulcer may be excised. Still gastro-jejunostomy has not been proved to do away with the need of local treatment of the ulcer in all cases, for Mansell Moullin and others have recorded cases in which hæmorrhage recurred in spite of this operation. Dr. F. G. Connell (*Ann. of Surg.*, 1904, vol. xl. p. 500) has collected 10 cases where gastro-jejunostomy failed in its object. Seven of these ended fatally. Dr. Ticehurst also records two cases in which gastro-jejunostomy was of no avail, and in one of these patients no definite source of hæmorrhage was found either at the operation or after death. The other patient, a young man, died of recurrent hæmorrhage from multiple erosions in spite of gastro-jejunostomy and ligation of many bleeding points. Paterson contends that the recurrence may be due to malignant disease, to inefficient drainage, or to the use of mechanical contrivances in making the fistula. It may be concluded that a gastro-jejunostomy is indicated in all cases, and that in a few an accessible ulcer may be infolded with Lembert's sutures at the same time.

DIGITAL DILATATION OF THE ORIFICES OF THE STOMACH.

We owe this operation to Prof. Loreta,* of Bologna, whose two first cases Mr. Holmes was, I believe, the first to bring prominently under the notice of English surgeons.

* Prof. Loreta's first case is reported in the *Lancet*, Aug. 18, 1883. The ninth operation, one of dilatation of the cardiac orifice, is briefly given in the same journal April 26,

Dilatation of simple stricture of the œsophagus has been already discussed (p. 455). Digital or instrumental dilatation of the cardiac orifice may be performed from the stomach, and subsequent contraction may be prevented by means of bougies.

Pylorodiosis, or digital dilatation of the pylorus, has been almost entirely replaced by some form of gastro-enterostomy or pyloroplasty.

The contracted pylorus has been stretched by means of one or more fingers introduced through an incision in the anterior wall of the stomach. Forceps or various dilators have been found necessary to start the dilatation and to allow the introduction of a finger, and much force has been required to produce the necessary amount of dilatation or tearing.

Hahn introduced a finger into the pylorus by invaginating the anterior wall of the stomach, thus avoiding the need of an incision and the risks of it, but it is clear that the amount of force which is often required to dilate the pylorus could not be exerted in this way without seriously damaging the wall of the stomach. Moreover, the contraction may be so tight, that the finger cannot be passed into it.

Although the operation has been of use in some cases of fibrous stricture of the pylorus without ulceration, and in some cases of congenital hypertrophic stenosis, it is not surprising that it has fallen into disfavour, because it is not founded upon sound principles. The laceration of the deeper tissues, and even of the mucous membrane, that must occur during the forcible dilatation, would be expected to be followed by interstitial hæmorrhage, inflammation, and a great tendency to recontraction. Such a narrowing, often worse than the original, does in fact usually occur, and there is no means of preventing it. No instrument can be tied in during the contractile stage, as, after forcible dilatation of urethral stricture, ulceration and hæmorrhage also have followed pylorodiosis.

Mayo Robson collected the records of seventy-eight of these operations for his Hunterian lecture in 1899, and found the mortality to be 39·7 per cent. Of course it is hardly fair to compare this high death rate with that of gastro-enterostomy (3 to 5 per cent.) at the present day.

Paterson (Hunterian Lectures, 1906; *Lancet*, vol. i. 1906, p. 577) found that this operation has been performed twenty-one times for infantile hypertrophic stenosis of the pylorus. Fifteen of the patients recovered from the operation. In three cases the pylorus or duodenum was ruptured, and death resulted in two of these; in the other the rent was recognised and sutured during the operation.

Relapse occurred in several of those patients who survived the operation, and in at least two of these death followed the recurrence of the obstruction; a third patient recovered after a secondary gastro-enterostomy. There is little doubt but that gastro-jejunostomy and pyloroplasty are preferable to pylorodiosis, although the immediate mortality of these operations has been greater in the past.

1884. Mr. Holmes' summary, a very full one, of two papers by Prof. Loreta, will be found in the *Brit. Med. Journ.*, Feb. 21, 1885. Any surgeon about to perform these operations should refer to this. Mr. Haggard's case—the first successful one performed by an English surgeon—was published in the *Brit. Med. Journ.*, Feb. 19, 1887. In the same journal for March 17, 1888, is a note that the patient continues perfectly well.

PYLOROPLASTY.

This is a scientific advance on Prof. Loreta's operation for the relief of non-malignant strictures of the pylorus, *e.g.*, those due to congenital stenosis, corrosive poisoning, injury, cicatrised ulcers, and chronic gastritis. We owe the operation to Heineke and Mikulicz, who performed it independently in 1886 and 1887.

In pyloroplasty a definite plastic operation replaces a divulsion performed more or less in the dark. The two operations are very well contrasted by Mr. Pearce Gould in an instructive paper (*Lancet*, 1893, vol. i. p. 1183):—"Of the two methods of obtaining a wider pylorus, pyloroplasty was chosen as safer and more likely to be permanently successful than Loreta's operation of divulsion. Both operations entail incision into the stomach and subsequent suture of the wound; so far their perils are the same. But whilst pyloroplasty consists of a clean cut through the anterior wall of the pylorus, where it is most free from large vessels and under the operator's eye, the effects of divulsion are not seen, and may be more or less than the surgeon intends, and may be inflicted upon important vessels. The statistics of Loreta's operation show cases of death from complete rupture of the pylorus on its posterior aspect, and also from hæmorrhage; the plastic operation is entirely free from these dangers.* A further most important consideration is the question of relapse. Divulsion has been followed by recurrence of the stricture, and in many cases the operation has been repeated; and, looking to analogous cases, this is what one would expect. A sudden dilatation of the strictured urethra or rectum is well known to be followed by relapse unless special means are used to maintain the enlargement. All such special means are inapplicable in the case of the stomach. Stretching the pylorus may consist of over-stretching the muscular ring, analogous to stretching the sphincter ani. This may be entirely satisfactory in its result; on the other hand, it may effect a tearing and stretching of fibroid or cicatricial tissue—a process known to be very unsatisfactory in many cases. Pyloroplasty, on the other hand, introduces new and presumably healthy tissues into the pyloric ring, tissues with no tendency to contract."

The stomach should be washed out thoroughly on the day before the operation. The lavage should be repeated about two hours before the operation, and a saline enema given. To lessen the risk of pulmonary complications, the teeth and mouth should be well cleansed for a day or two, and an antiseptic mouth wash used. Only boiled milk should be given by the mouth for two days before the operation.

Operation (Figs. 172 and 173).—The abdomen having been opened by a free incision through the sheath of the right rectus, the muscle drawn well outwards, and all hæmorrhage stopped, the pylorus is found, brought out of the wound if possible, and in any case well packed around with tampons of sterile gauze. Adhesions between the pylorus and omentum, or between the pylorus and the liver, may

* Mr. P. Swain, of Plymouth, whose operative experience is well known, has candidly published (*Lancet*, 1892, vol. i. p. 87) two cases of digital dilatation of the pylorus which ended fatally. Both patients were in very weak condition; one died of continued vomiting. In the other, the duodenum, which was very thin, was torn quite through behind, at its junction with the pylorus.

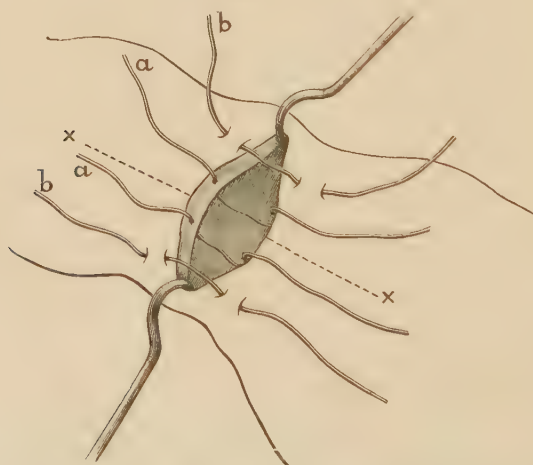
need separating. A transverse incision is then made into the anterior wall of the stomach, just internal to the pylorus, by which the stricture is examined from within. The incision is next prolonged transversely through the strictured pylorus into the duodenum, making it about two inches long. Any vessels which spurt must be clamped. Any contents

FIG. 172.



Pyloroplasty, first stage, showing the longitudinal incision. (Pearce Gould.)

FIG. 173.



Pyloroplasty, second stage, showing the longitudinal wound converted into a transverse by retraction. (Pearce Gould.) It is far better to make the deep suture pierce all the coats.

of the stomach which may escape are carefully removed on gauze. The transverse incision is then widely opened out by two blunt hooks, placed in the centre of each side; this produces a wound of lozenge shape, which is united so as to form a vertical one. Any soiled sponges or tampons being renewed, the sutures are inserted in a double row. There are several ways of doing this. A continuous suture uniting the mucous membrane and a row of Lembert's sutures, carried well into the muscular coat, have been used successfully (Fig. 173). Considering the tension, I prefer to make the deep stitch pierce all the

coats, to secure a firmer hold. The knots of this should be upon the mucous surface (*vide* Figs. 106, 107 and 166). This stitch should be reinforced and buried by a continuous sero-muscular suture. Fine silk should be used on ordinary round sewing-needles. To strengthen the line of suture any tags of peritonæal adhesions which have been separated and left attached near the incision may be brought together and fixed over it by a few points of suture. The after-treatment will be that given at p. 522.

Successful cases will be found recorded by Mr. Page, of Newcastle (*Lancet*, 1892, vol. ii. p. 84); Mr. Gould, *loc. supra cit.*; Mr. Morison (*Lancet*, 1895, vol. i. p. 396). Mr. Gould quotes several foreign operators, and, having collected 23 cases, finds the mortality to be about 25 per cent. Mr. M. Robson (*Brit. Med. Journ.*, 1900, vol. i. p. 627) makes use of his decalcified bone bobbin. This, besides steadying the line of sutures for twenty-four or forty-eight hours, secures an immediately and thoroughly patent channel. The same author (*loc. supra cit.*) also remarks as follows on the limitations of this operation:—"If, owing to cicatrisation of the ulcer, there is extensive hypertrophy of the pylorus with a large amount of thickening, pyloroplasty is insufficient, as in such cases contraction will be likely to recur. Here pylorotomy may be performed, as in two cases of my own, or, better still, gastro-enterostomy, which is a simpler, quicker, and safer operation. Numerous and firm adhesions, active ulceration, and the presence of new growth, are also contra-indications for pyloroplasty. Pyloroplasty with partial excision seems the right practice in bad organic stricture. The dense tissue being cut away, the lozenge-shaped incision can be readily sutured so as to become transverse; whilst, if a simple longitudinal incision is made through the tissues of a dense stricture, it is impossible to convert it safely into a transverse line of sutured wound, owing to the great tension if the two ends be made to meet in the middle."

Mr. Robson collected the records of thirty-eight operations for his Hunterian Lectures, and found the mortality to have been 15·4 per cent. Since then the results have improved greatly. Thus in Robson and Moynihan's last twenty-seven pyloroplasties only one death occurred.

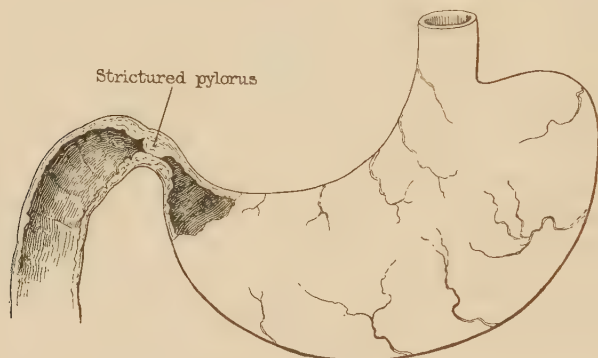
Pyloroplasty does not drain a dilated stomach nearly so well as gastro-jejunostomy, nor does it provide rest for the diseased pylorus, but vomiting from the so-called vicious circle cannot follow the ordinary pyloroplasty. Recurrence of the contraction, or even ulceration, may slowly develop, and give rise to serious symptoms even after several years. Paterson (*Lancet*, vol. i. 1906, p. 498), from an analysis of the published cases, concludes that relapse occurs in at least 27 per cent. of the patients. Out of 22 cases followed up by Paterson himself, relapse occurred in 12. Secondary gastro-jejunostomy has not uncommonly been required and performed. The operation has been more successful in cases of congenital hypertrophic stenosis, the immediate mortality being less than that of gastro-jejunostomy in these usually marasmic patients, and the after-results being excellent in the 5 cases that survived (Paterson, *loc. cit.*, p. 578).

Finney's Operation (*Bull. Johns Hopkins Hosp.*, July, 1902).—Dr. Finney described his ingenious operation as a new method of pyloroplasty, but it is also a form of gastro-duodenostomy. The

pylorus, the pyloric end of the stomach, and the first part of the duodenum are thoroughly freed from adhesions, so that the subsequent steps may be made easy and all tension prevented. Finney lays stress on the need of dividing the adhesions very thoroughly, and considers this to be one of the most essential points of the operation.

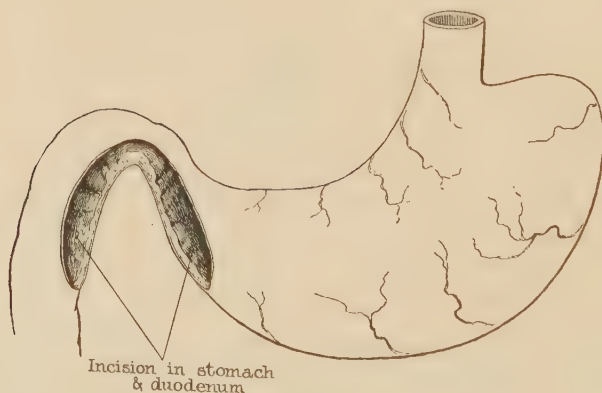
Retractor sutures are inserted at the upper border of the pylorus, and low down on the anterior walls of the stomach and duodenum (*vide* Fig. 176). Traction is made upon these threads for the double

FIG. 174.



Finney's operation. Strictured pylorus.

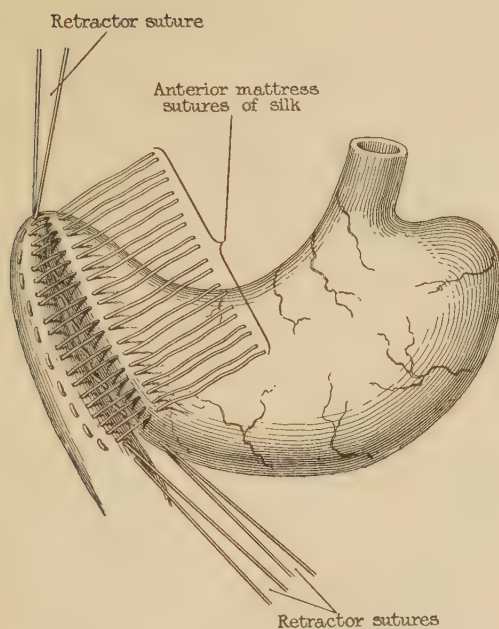
FIG. 175.



Finney's operation.

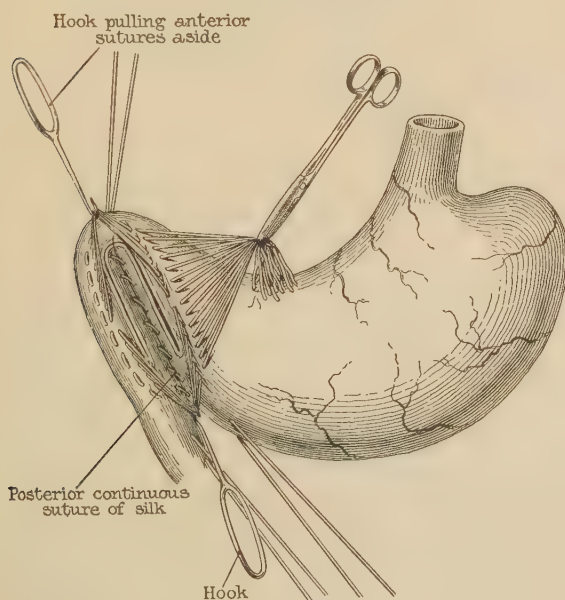
purpose of bringing the stomach and duodenum together and holding their walls taut, to facilitate the insertion of sutures. A continuous sero-muscular suture is first used to join the stomach and duodenum as far back as possible (*vide* Fig. 177); anterior mattress sutures are then placed to complete the circle of sero-muscular stitches (*vide* Fig. 176). The anterior sutures are retracted as shown in Fig. 177, and a horseshoe-shaped incision is made within the line of sutures (Figs. 175, 177). The incision divides the stricture near its lower border and extends well into the stomach and duodenum. To limit subsequent contraction, as much of the scar tissue as possible is removed

FIG. 176.



The posterior continuous sero-muscular suture is shown. Finney's operation.
(After Finney, *Bull. Johns Hopkins Hosp.*)

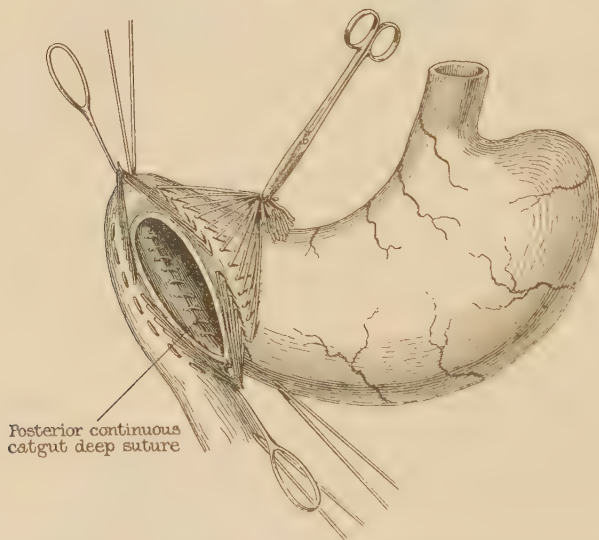
FIG. 177.



The horseshoe-shaped incision is shown. Finney's operation. (After Finney, *Bull. Johns Hopkins Hosp.*)

from either side of the incision, especially if the walls of the pylorus are much thickened. To prevent the formation of obstructing valves, and to make suturing easier, redundant edges of mucous membrane are removed. Hæmorrhage is arrested, and the posterior edges of the incision are joined together by means of a continuous catgut suture, which pierces all the coats of the stomach and intestines (Fig. 178). This suture reinforces the posterior sero-muscular stitch, secures better contact of the edges, and prevents the reunion of the anterior to posterior edges of the opening. The anterior sutures are then tied and the operation completed (Fig. 179). Scudder uses continuous instead of interrupted sutures, and Gould employs clamps for the control of hæmorrhage (Finney, *Lancet*, 1905, vol. ii. p. 327). Both these modifications are of value, for they make the operation easier, simpler, and

FIG. 178.



Finney's operation. (After Finney, *Bull. Johns Hopkins Hosp.*, July, 1902.)

safer. The clamps are used in just the same way as for gastro-jejunostomy, and the advantages of using them are discussed at p. 501.

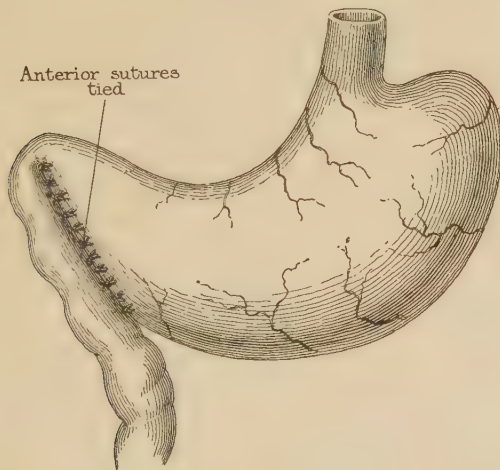
The advantages claimed for this operation are—that it is easy and simple to perform; that the risk of infection is very slight, owing to the minimum exposure of infective surfaces; that the size and position of the new orifice are such as to provide free drainage of the stomach, unless the latter is greatly dilated; that spur formation and the development of a vicious circle are impossible; and that there is a peculiar freedom from post-operative nausea and vomiting [regurgitation of bile does occur in some cases, however]; and further even a large ulcer may be removed from the anterior aspect of the pylorus or stomach without fear of subsequent cicatricial contraction. It does not interfere with digestion in the duodenum and with the reflex secretion of bile and pancreatic juice; hence absorption should be better than after short-circuiting.

Disadvantages.—Although the operation is a great improvement

on pyloroplasty, the separation of adhesions is troublesome, and may be dangerous. The after-results are not so good as those of gastro-jejunostomy. It is contra-indicated in most cases of active ulceration, or with dense adhesions, and its mortality is higher than that of gastro-jejunostomy. The mesogastrium may be too short or the duodenum may be too fixed to allow easy approximation of the parts that may then have to be joined in the depth of the wound. Finney (*Lancet*, 1905, vol. ii. p. 327) states that he has performed the operation twenty-five times, and that he has collected the results of 112 operations performed by twelve surgeons; the death rate was just under 9 per cent. In fifty-eight of these operations Dr. W. J. Mayo had a mortality of a little less than 7 per cent. (*Ann. of Surg.*, 1905, vol. xlii.).

It may be concluded that Finney's operation is neither so safe nor

FIG. 179.



Finney's operation. (After Finney, *Bull. Johns Hopkins Hosp.*)

so generally applicable as gastro-jejunostomy, but that in slight cases, with few adhesions, and in the absence of an irremovable ulcer, it may be the operation of choice occasionally.

GASTRO-DUODENOSTOMY.

This operation was designed by Jaboulay with the object of overcoming pyloric stenosis, and yet to allow the food to enter the duodenum for digestive purposes, and particularly with the view of preventing the development of a vicious circle or regurgitant vomiting. Theoretically gastro-duodenostomy is, on these two accounts, better than gastro-jejunostomy, but, as a matter of fact, some bile regurgitation may follow gastro-duodenostomy, if the opening be made as large as in Finney's operation and others. At the present time regurgitant vomiting after a proper gastro-jejunostomy has ceased to be the terror of surgeons, although it still occurs occasionally, especially with loop operations and an open pylorus.

It remains to be proved that a posterior gastro-jejunostomy without a loop does really and seriously interfere with normal digestion and absorption in non-malignant cases, and abundant clinical evidence

points strongly the other way. Dr. Cameron tells me that in one of my cases, which he has kindly investigated, the absorption of fat was less than normal during the second week; but the man is rapidly putting on weight. There is no risk of peptic jejunal ulcer following gastro-duodenostomy, and even a duodenal one is extremely unlikely to develop, for the acid chyme now enters quite near the biliary papilla, and is soon neutralised by the bile and pancreatic juice.

This operation is either impracticable or unsuitable for malignant disease, for if the growth is too extensive for resection, it is also too extensive for gastro-duodenostomy, and if there is some reason against resection, while the growth is small enough to allow gastro-duodenostomy the new opening will soon be invaded and obstructed by extension of the growth. In rare cases of extensive adhesions of all the stomach except near the pylorus in front, gastro-duodenostomy may be of great value, but the adhesions are usually limited to the pyloric region.

When an active ulcer at or near the pylorus can be excised, a gastro-duodenostomy may be so designed as to do this and drain the stomach at the same time as in Finney's operation (*vide* p. 472). When the stomach is considerably or greatly dilated, gastro-jejunosomy is undoubtedly to be preferred over gastro-duodenostomy, and, as far as the available evidence goes, this operation is both simpler and safer in the great majority of cases. As compared with such unsatisfactory operations as pylorodiosis and pyloroplasty, gastro-duodenostomy has the great advantage of avoiding diseased tissues.

Although Kocher had previously joined the open end of the duodenum

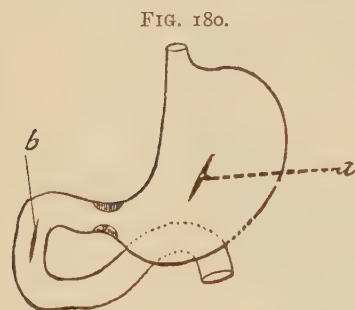


FIG. 180.
Jaboulay's method of gastro-duodenostomy. (Mayo Robson and Moynihan.)
a. Incision into the stomach. It would be better to place this much lower down. *b.* The wound in the duodenum.

to the posterior surface of the stomach after resection of the pylorus, Jaboulay was the first to suggest gastro-duodenostomy as a lateral anastomosis. He joined the duodenum to the anterior surface of the stomach by making a vertical incision in each, and folding the duodenum over and to the left. This is only possible with a very movable duodenum, or after making it mobile by Kocher's method. Villard made a fistula between the neighbouring surfaces of the duodenum and dilated stomach below and quite near the pylorus, which is a difficult procedure. Prof. Kocher mobilises the duodenum so that it can be more easily and safely joined to the stomach. He gives the following description of his method.*

"The most suitable incision is one similar to that which we recommended for exposing the gall-bladder, viz., an oblique incision two fingers' breadth below and parallel to the right costal margin, beginning at the middle line (*vide* Fig. 211, p. 531). After dividing the skin and fascia, the rectus muscle is cut through as far as the broad abdominal muscles. The posterior layer of the rectal sheath, the fascia

* *Operative Surgery*, translation by Stiles, 1903, Appendix, p. 433.

transversalis, and the peritonæum are divided. In muscular subjects, the transversalis muscle is split parallel to its fibres, which are then firmly drawn apart. Should any adhesions exist between the gall-bladder and the colon, they must be divided. The liver is drawn upwards, and the stomach to the left, and the transverse colon and the descending limb of the hepatic flexure downwards. The duodenum is then brought into view, and its outer border clearly defined. A pad of gauze is placed against the under surface of the liver, and the latter is then drawn well upwards with a suitable retractor. Gauze compresses are also employed to push aside the stomach and the colon.

"The delicate layer of the parietal peritonæum covering the kidney is divided vertically one and a half inches external to the second part of the duodenum, and the incision is then continued vertically downwards through the upper layer of the transverse mesocolon (which is held on the stretch) as far as the larger branches of the vessels. The fingers are then introduced behind the left edge of the incision through the peritonæum, and the duodenum is separated from the vertebral column, the vena cava, and the aorta, until it can be brought forward and pressed against the pyloric portion of the stomach, which, in its turn, is compressed against the left edge of the wound in the abdominal wall, so as to shut off the general cavity of the stomach and prevent escape of its contents. Both stomach and duodenum are now compressed above and below between the fingers of an assistant, and the lateral anastomosis is effected in the usual manner by two rows of sutures. To one who has convinced himself how easily and securely this lateral gastro-duodenostomy can be performed, provided the duodenum can be rendered sufficiently movable, it will be evident how admirably the operation fulfils the indications for treatment of stenosis of the pylorus. Unlike other surgeons who have performed gastro-duodenostomy, we do not limit the operation to special cases; on the contrary, we regard it as the normal procedure, and we are of opinion that it will take precedence over all previous methods of gastro-enterostomy and pyloroplasty.

"The method is subject to only one contra-indication, viz., the presence of such extensive adhesions to the under surface of the liver, that the duodenum cannot be sufficiently freed. This difficulty of adhesion can, however, often be overcome, as we have proved in three of our cases; but the fact of having to perform the suturing inside the abdomen is apt to interfere with the security of stitching, especially in difficult cases. It is on this account that subpyloric gastro-duodenostomy did not meet with universal acceptance. The subpyloric portion of the duodenum cannot be drawn out of the wound, on account of its connection with the gastro-hepatic omentum and the important structures contained within it. This fixation to the under surface of the liver may be so firm that only the lower two-thirds or only the lower part of the vertical portion of the duodenum, together with the inferior flexure, can be brought in contact with the stomach.

"We therefore propose that, instead of Villard's subpyloric gastro-duodenostomy, the name **lateral gastro-duodenostomy** be given to this operation to distinguish it from our method of inserting the divided duodenum into the posterior wall of the stomach after resection of the pylorus. The great difference between Villard's subpyloric

gastro-duodenostomy and our procedure is, that we render the descending portion of the duodenum, the inferior flexure, and a considerable portion of the third (transverse) part so movable that the parts to be sutured can readily be raised up and surrounded with gauze, so that the sutures can be introduced extra-peritonæally with comfort and security.

"We intend in future to perform lateral gastro-duodenostomy in all cases of stricture of the pylorus, and only to perform gastro-jejunostomy in cases rendered unusually difficult by firm adhesions. We have performed the operation on five occasions, four times for cicatricial stenosis and once for malignant stricture. The results have been convincing. "Regurgitation of bile either does not occur at all, or only at first, when a large gaping opening has been made. It is advisable to make the anastomotic opening as high as possible in the duodenum and not too large. The patient with carcinoma was at once relieved of all her discomfort. Only one patient complained subsequently of very severe pain, and he had a simultaneous cholecystostomy performed for gall-stones. That a dilated and sacculated stomach is not so well emptied as by our inferior gastro-jejunostomy is obvious. If gastro-duodenostomy be performed in such a case, it is advisable to occasionally wash out the stomach."

It is to be noted that even Prof. Kocher found adhesions troublesome in three out of his five cases. Although operation may appear easy to him, it is certain that for those of less experience gastro-jejunostomy is easier and safer to adopt in the large majority of cases.

PYLORECTOMY ; PARTIAL GASTRECTOMY.

This operation, which we owe especially to German surgeons—*e.g.*, Billroth, Wölfler, Gussenbauer, and v. Winiwarter—has not hitherto been so largely practised in England as elsewhere. The principal indication is malignant disease, although the operation has occasionally been performed for non-malignant stenosis of the pylorus (*vide supra*). The original method of end to end direct suture has been largely replaced by the more expeditious methods, in which the divided ends of the stomach and duodenum are closed by suture, and a gastro-duodenostomy or gastro-enterostomy then performed. On several occasions also the operation has been performed in two stages, the gastro-enterostomy being first performed; then, after the general condition of the patient has improved as a result of the relief from pyloric stenosis, the removal of the pylorus is carried out. This has been done by Tupolske, Hahn, Franke, Barker, and others. Mr. Mayo Robson (*Brit. Med. Journ.*, vol. i. 1900, p. 696) objects, however, to this plan on the ground that the patient may derive so much benefit from the first operation that he cannot be always brought to see the necessity of a second operation until it is too late to be successful. The resection may alter the anatomical relations so much, that kinking and obstruction of the opening into jejunum takes place. Paterson lost one patient from this cause.

The improvements in technique have led to a considerable diminution in the mortality, as may be gathered by a comparison of the following sets of cases collected in 1885 and 1900:—

Mr. Butlin quotes Bramer (*Cent. f. Chir.*, 1885, p. 548) as having

collected 72 cases of pylorectomy for cancer, of which 55 died from the operation, a mortality of 76 per cent.

Mr. Mayo Robson (*loc. supra cit.*) gives a table containing 572 cases, with 174 deaths, a mortality of 30.4 per cent. Some operators have, moreover, published recent lists showing even far better results than these. For instance, Maydl had only 4 deaths in 25 cases, and Kocher only 5 deaths in 57 cases.

Mr. Paterson in his Hunterian Lectures on Gastric Surgery (*Lancet*, 1906, vol. i. p. 580) gives a number of valuable and recent statistics. Thus Kocher had performed 110 resections for carcinoma of the stomach up to the end of 1905, with a mortality of 24 per cent., but since 1898 the death rate of 58 cases has been only 15 per cent. Drs. W. J. Mayo and C. Mayo had performed 100 resections up to the end of 1905, with a mortality of only 14 per cent.

Such results are not attainable without special experience, and it is probable that a mortality of from 20 to 25 per cent. would be considered to be a low one by most surgeons, who do not get their cases so early as those who are known to have unusual experience of gastric surgery. Mr. Moynihan (*Clin. Soc. Trans.*, 1906, p. 87) lost three of his ten cases, a mortality of 30 per cent., but these figures include one case of total gastrectomy.

As regards the question of pylorectomy compared with gastro-jejunostomy only, the following words of Dr. Macdonald's (*Ann. of Surg.*, February, 1901, p. 160), referring to the results of pylorectomy, may be quoted:—"I have taken occasion recently to make a cursory investigation of the literature with relation to this subject, and have been able to find 43 cases for which pylorectomy was done for carcinoma of the stomach, and that the patients were living without recurrence three years after the operation, and that there were patients in this group who were alive ten years after the primary operation, without symptoms of recurrence. I may also say that this group of 43 cases is collected from among 527 operations done for the relief of pyloric carcinoma, with an immediate mortality of 31 per cent. In other words, we have from the work already done rather more than 8 per cent. of final recoveries as judged by ordinary standards. This will compare very favourably with the ultimate success which we enjoyed a few years ago in the treatment of cancer of the breast."

From an analysis of the recorded cases of total and subtotal gastrectomy and a number of partial gastrectomies Paterson concludes that over 8 per cent. of the patients remain well for over five years, and may be considered to be probably cured. In Kocher's series of "97 consecutive cases 8 per cent. of the patients are alive and well over five years after the operation, and of the 42 patients who have died only 2 died later than three years and a half after the operation."

Before deciding between a pylorectomy on the one hand and a gastro-jejunostomy only on the other, the following conditions must be most carefully considered:

- i. The size, site, and degree of fixation of the growth. Is the mass small, circumscribed, and localised to the pylorus?—*i.e.*, how far is it (a) without any secondary deposits? (β) free from adhesions? It is probably quite impossible to be certain as to these

points. While in many cases cancer of the pylorus may remain long limited to the pylorus itself, it is very liable to infect the omenta and the lymphatic glands around the head of the pancreas, and to cause secondary growths in the liver and other parts.* Adhesions, too, are very frequently† met with between the stomach and the colon, pancreas, and liver.

When adhesions are present the immediate mortality of the operation is greatly increased, and this is especially true of adhesions involving the pancreas; in these cases Mikulicz had a mortality of 70 per cent. The prospects of permanent relief are of course much diminished, for the growth follows closely in the wake of inflammatory adhesions. The more the growth has extended towards the cardiac orifice along the lesser curvature, the less the chance of successful resection.

Slight enlargement of the lymphatic glands is not a contra-indication to resection, for the glands are very frequently found to be merely inflammatory, and they may be seen near a simple ulcer.

When the glands are of large size and adherent, it is generally too late to attempt the removal of the growth. In the great majority of cases, an exploration should be undertaken before any tumour can be felt, but it is certainly not true that resection may be considered to be impracticable because a tumour is evident, for even the induration around a simple pyloric ulcer may be felt in thin patients. It must not be concluded from the apparent mobility of a growth felt through the abdominal wall that a resection is practicable, or *vice versa*.

The following cases show how easily the surgeon may be mistaken in regard to these points. In Mr. Southam's patient (*Brit. Med. Journ.*, July 29, 1882—an instructive paper, from which I shall again quote later), aged 43, though the hard nodular mass in the situation of the pylorus moved with respiration, and shifted as the patient moved from side to side, though the symptoms were only of four months' duration, and the disease appeared to be limited to the pylorus, there were a mass of enlarged glands surrounding the head of the pancreas, and some slight adhesions of the stomach to these. Mr. Morris mentions a patient of Prof. Lietherin in whom, though the growth could be easily moved in different directions, it was found so firmly adherent that the operation had to be abandoned.

From a careful consideration of the symptoms, and the results of chemical and microscopical examinations of the gastric findings, &c., the diagnosis should be more frequently made before the growth becomes irremovable; and with this object an early exploration should be undertaken, when the symptoms do not yield to treatment and strongly suggest the probability of the existence of carcinoma of the stomach. The danger of an early exploration is very small, although a simple exploration in late and inoperable cases carries with it a very considerable risk of death, as shown by the experience of Kronlein and Mikulicz, who had a mortality of about 9 per cent. in such late explorations.

* McArdle (*Dublin Journ. Med. Sci.*, vol. lxxxiii. p. 511), having collected from the statistics of different writers 1,342 cases, states that the pylorus alone was involved in 802, or over half the cases.

† The statistics of Gussenbauer and Winiwarter (*Langenbeck's Arch.*, Bd. xix. p. 372, 1876) show that, of 542 cases of cancer of the pylorus, adhesions were present in 370.

Moynihan (*Clin. Soc. Trans.*, 1906, p. 89) has recently drawn attention to this point. One of his six cases died.

ii. The strength and age of the patient. The general condition, power of repair, &c., must be sufficient to justify the patient being submitted to an operation on very vital parts, which will certainly take more than an hour, and may take an hour and a half or two hours.

iii. The rate at which vomiting, pain, and emaciation are increasing. Where this is marked, resection should be abandoned.

Where the surgeon remains in doubt as to the advisability of resection up to the time that the abdomen is opened, the presence of extensive adhesions between the stomach and adjacent parts, liver, pancreas, &c., the existence of secondary deposits, the extension of the disease into the omenta, if any of these are present, resection should be abandoned.

Partial gastrectomy is now more frequently undertaken than a few years ago, for in suitable cases it is far preferable to gastro-jejunostomy. The mortality of resection in skilled hands is not much greater than that of gastro-enterostomy. Mikulicz, Carle and Fantino, have even had a lower mortality from resection than from gastro-enterostomy in cancerous cases. In the three years ending in 1901, Mikulicz had a death-rate of 26·5 per cent. for gastro-enterostomy and 25 per cent. for resection of the growth.

The comfort and relief of the patient is far greater after resection, and the prolongation of life even when recurrence follows is longer by nearly a year. Moreover, resection does give an appreciable chance of freedom from relapse, whereas the only hope of permanent recovery after gastro-jejunostomy is that a mistaken diagnosis has been made. The high mortality and the comparative discomfort of patients after gastro-enterostomy for carcinoma are due chiefly to toxæmia and hæmorrhage from the breaking down growth. Septic pulmonary complications are also very frequent.

If resection be decided upon one of the following methods may be adopted:—

- i. *Kocher's method, or Hartmann's modification of this method.*
- ii. *Resection with direct suture of the divided ends, without or with the aid of a mechanical contrivance (Billroth's first method).*
- iii. *Resection combined with gastro-jejunostomy (Billroth's second method).*

The researches of Cuneo, Lindner, and others have shown us that carcinoma spreads (a) early and widely in the submucosa, (b) towards and along the lesser curvature towards the cardiac orifice, and (c) to the glands in the lesser and greater omenta, and those lying near the head of the pancreas; but real dissemination is a comparatively late occurrence in gastric carcinoma.

There is very little tendency for the disease to spread along the greater curvature towards the left into the fundus, which can be safely left in pyloric and prepyloric growths, which form the large majority of gastric cancers.

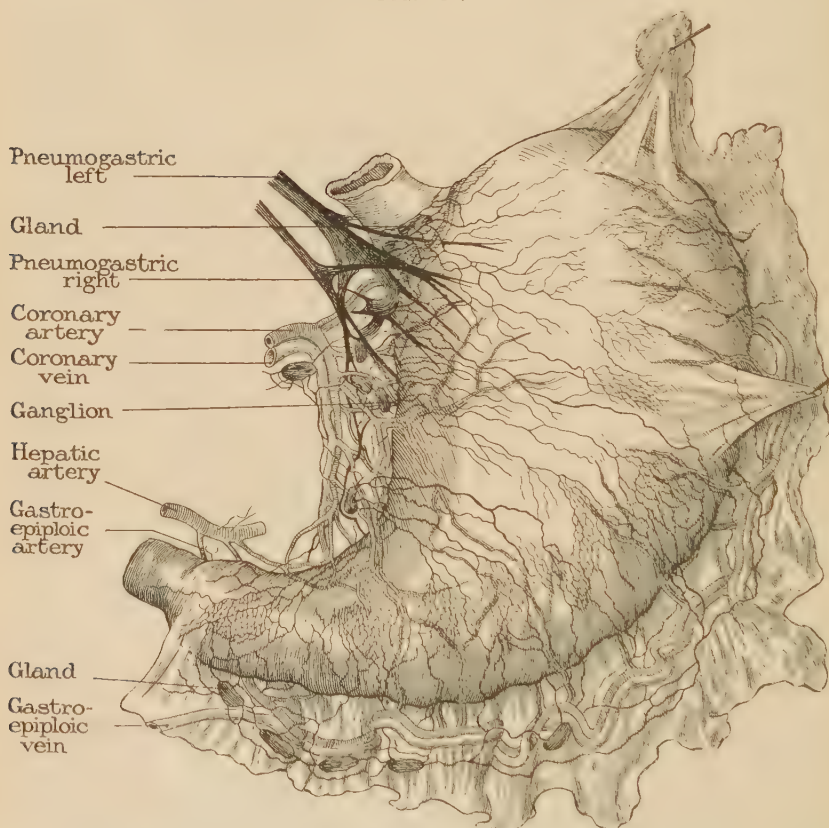
It is clear, therefore, that resections must be wider than hitherto, especially as regards the lesser curvature and the lymphatic vessels and glands. It is also evident from modern results that wide resections can be undertaken without much, if any, more risk than pylorectomy,

and that resections can be hopefully undertaken later than we used to think.

Preparation.—For some days before the operation the stomach should be washed out with tepid water, syphon fashion, by an india-rubber tube and funnel, till the contents come out clear, this being done more frequently according to the degree of dilatation of the viscus.

The stomach should be gently washed out again about three hours before the operation, care being taken not to exhaust the patient by

FIG. 181.



The anatomy of the stomach after Hartmann and Cuneo. (Mayo, *Ann. of Surg.*)
Note the distribution of the lymphatics and the blood-vessels.

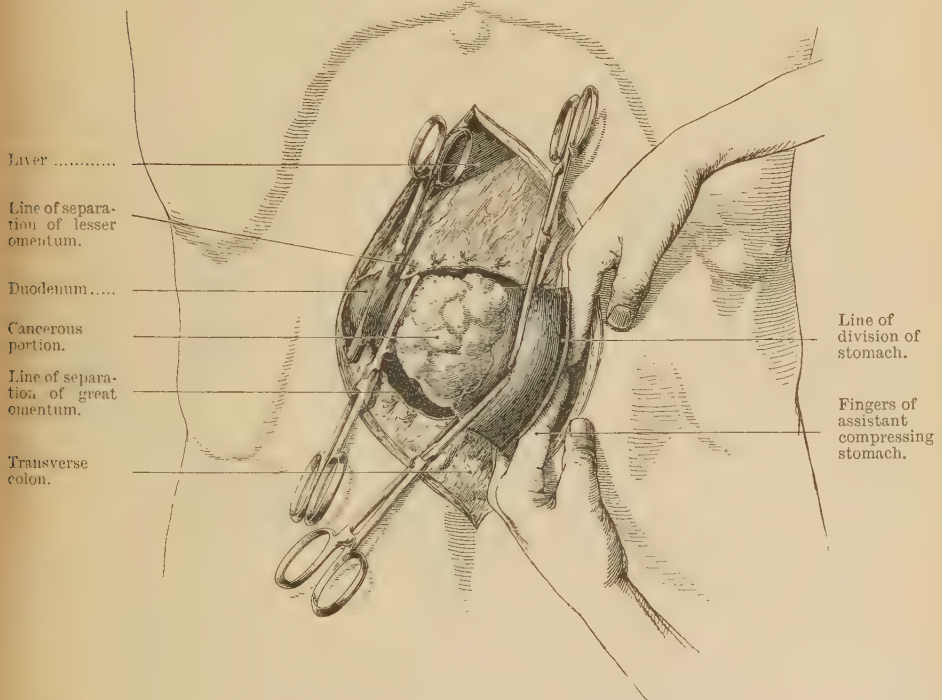
needless prolongation of the lavage, and undue exposure. The teeth and mouth should be thoroughly cleansed for several days, and an antiseptic mouth wash used, with the object of preventing septic pulmonary complications as far as possible. No food should be given by the mouth on the day of the operation, but liquids and jelly may be given on the preceding day. Nutrient enemata may be commenced twenty-four hours before the operation, and a pint of normal saline solution may be administered an hour before the operation.

Rectal or subcutaneous saline infusion may also be given in

exhausted and weakly patients, and this is generally necessary to combat shock after the operation. Continuous or repeated small infusions are better than one large one. Every precaution at the time of the operation should be taken against shock—viz., wrapping up the patient well, a hot-water bed, hot bottles, bandaging the limbs in flannel, keeping the head low, the administration of ether if possible, or A.C.E., for the greater part of the operation, and subcutaneous injections of strychnine or brandy.

Mayo recommends the subcutaneous injection of morphia before the operation, so that only a small amount of ether need be given, and shock thus lessened.

FIG. 182.



Resection of pylorus, first stage. (After Kocher.)

At the present time the omenta are divided well away from the growth and beyond the lymphatic glands (compare Figs. 186 and 192). Instead of the fingers, Kocher now uses large curved crushing forceps, which hold the stomach more securely and prevent leakage more effectually. The line of gastric section is shown further to the left than in Kocher's original figure, but it does not extend high enough on the lesser curvature.

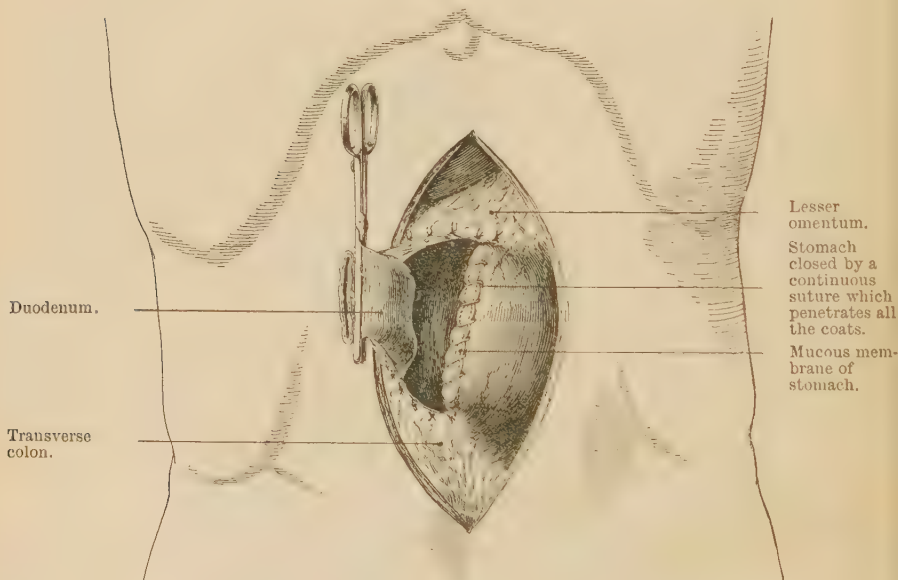
I. Kocher's Method.—Pylorectomy combined with gastro-duodenostomy.

This operation as originally described is too limited in extent for gastric carcinoma, but it may be suitable for some cases of simple ulceration, although gastro-enterostomy will be preferable in nearly all these cases. Kocher himself recommends Hartmann's modification of his method. Kocher's operation will not be described in detail, but

the three stages of it are illustrated in the figures, which are preserved for historical interest, and to emphasise the progress that has occurred in gastric surgery during recent years.

Hartmann's Modification of Kocher's Method.—The following account is largely taken from Kocher (*Operative Surgery* translation by Stiles, 1903, p. 214). A central incision is made from the tip of the ensiform cartilage to the umbilicus, and a transverse incision is carried from this across the rectus abdominis if more room is required. The growth and its connections are thoroughly examined, to determine whether the tumour is removable or not. It is lifted out if possible, and the lesser omentum and gastro-colic ligament are perforated well to the left of the growth. Two large pressure or crushing forceps are then

FIG. 183.



Resection of pylorus, second stage. (After Kocher.)

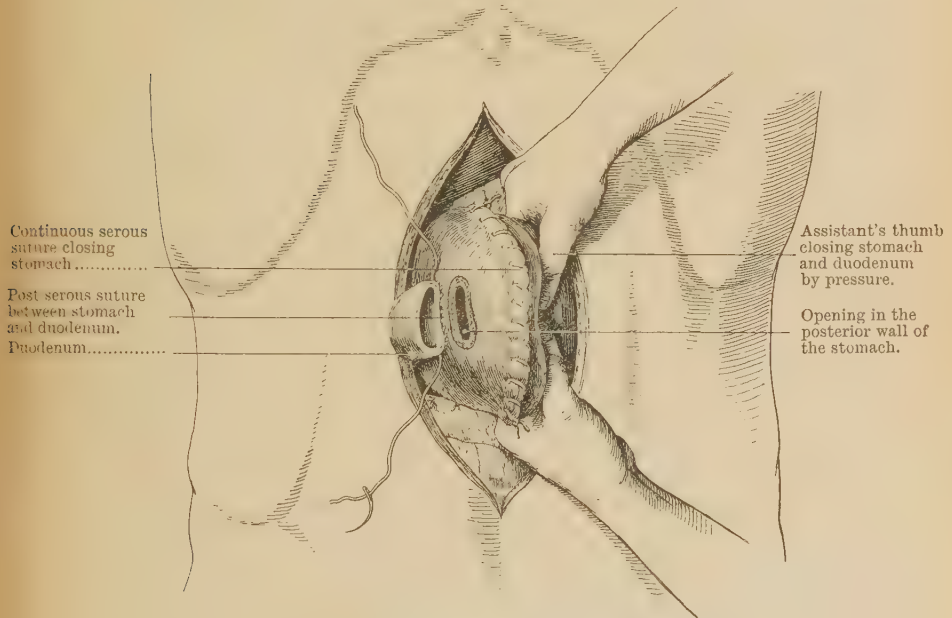
applied close together, with their points above the lesser curvature, close to the oesophagus, so that all the lesser curvature may be removed. Gauze is packed beneath the forceps, and the stomach is then divided between the clamps. The gastric artery is served between two ligatures, and the gastro-hepatic omentum is divided well above the glands. This makes the stomach much more movable, and allows it to be turned over towards the right. The lymphatic tissues and fat are removed as far as the pyloric artery, which is ligatured and divided. Any lymphatic glands upon the gastro-duodenal artery and the head of the pancreas are removed, and the right gastro epiploic artery tied near its origin. The hepatic artery should be carefully avoided.

By turning the stomach over to the right the posterior surface of the duodenum becomes accessible, so that the extent of the growth in this direction can be ascertained. The length and mobility of the

duodenum can also be determined, so that the surgeon may now decide if it is practicable to perform gastro-duodenostomy without exerting undue tension upon the anastomosis. Gauze is packed under the duodenum, which is then divided between two small crushing forceps. The cut edges are cleansed. The duodenal end can be joined to the stomach either before or after the large wound in the stomach is closed.

This wound is closed by passing a continuous mattress suture through the stomach just to the left of the crushing forceps, which are then removed. Traction is made upon the ends of the suture so that no leakage can occur. Any projecting mucous membrane or muscle which may have escaped crushing by the powerful forceps is clipped away

FIG. 184.



Resection of pylorus, third stage. (After Kocher.) Gastro-duodenostomy.

with scissors. A continuous over-stitch is then passed through all the coats of the stomach, so as to approximate the edges, and also fix each loop of the mattress suture, and finally the two rows are buried by means of a continuous Lembert suture.

The stomach and duodenum are then gently clamped at a convenient distance from the site of the anastomosis that is to be made, and the crushing forceps are removed from the duodenal extremity. This end is joined to the posterior surface of the stomach near the greater curvature and about one and a half inches from the occluded right extremity of the stomach.

An incision is made through the serous coat of the stomach; its length should be equal to the breadth of the flattened duodenum, and its direction parallel to the right border of the stomach.

A posterior serous suture is applied (*vide* Fig. 188). "The wall

of the stomach is then completely cut through, and a continuous suture passing through all the coats is applied so as to unite the posterior edges of the opening in the stomach and duodenum. A third continuous suture is applied so as to unite the two mucous edges. The anterior edges are now united by a continuous suture which passes through all the coats, and is knotted to the posterior suture. The clamp forceps, if such have been employed, are removed, and, lastly, the anterior serous suture is applied and knotted at each end with the posterior serous suture." To secure a patent opening it is well to excise some of the bulging mucosa of the stomach, and the usual deep and superficial continuous sutures are simple and satisfactory. The suture line is well swabbed with warm saline solution, and the gauze packs are removed. The abdominal wound is closed in layers and covered with a sealed dressing.

When the duodenum is not movable enough to be joined to the remains of the stomach, it may be mobilised by Kocher's method (p. 474), or its end may be occluded, and a gastro-jejunostomy performed (p. 486).

Kocher emphasises the following points as essential to success: (1) The operation must be performed *aseptically*, and the greatest care must be taken to avoid the entrance of disinfectants into the abdomen. Sublimate and its substitutes must only be used to disinfect the lines of suture and those areas of peritoneum which have been directly contaminated by the gastro-intestinal contents. Kocher thinks that collapse is often due to the too free use of such disinfectants. Even during a very prolonged operation salt solution should be employed exclusively for the swabs, and all the gauze placed around the wound. To prevent the entrance of gastro-intestinal contents, it is essential to use plenty of soft gauze. (2) As advocated by Rydygier and Lauenstein, *all the sutures*, the superficial serous and the deeper which take up the whole thickness of the wall, *must be continuous* and without the least interruption from one end of the wound to the other; this is why Kocher so strongly urges leaving the ends of the posterior sutures long after knotting them, so that they may be again reliably knotted with the anterior sutures. A perfectly secure closure is thus attained, and there is not the slightest necessity to prove that the suture is water-tight by distending the intestine. Another reason for carrying the continuous suture through the entire thickness of both gastric and intestinal walls is that only by this means can reactionary hæmorrhage, which has been the cause of a certain number of fatal cases, be prevented with certainty. Fine strong silk must be used for the sutures, not the less reliable catgut. Kocher has not seen any of the disadvantages ascribed to silk. He considers that Senn's method is more complicated than his own, and that its results have not quite fulfilled expectations. (3) *The employment of clamps*. Kocher considers these absolutely necessary for the closure of the cancerous portion, both on the duodenal and the gastric side. It is only in this way, as he has pointed out (*Centr. f. Chir.*, 1883, No. 45), that the dangerous escape of cancer juice can be prevented with certainty. The clamps have the following additional advantages: viz., that the intestine, and more especially the stomach, can be cut across along an exact line at the place desired, a matter which is otherwise not

always easy. Further, the use of clamps greatly shortens the operation. They produce complete closure, and serve as convenient handles for drawing up and manipulating the parts. They increase the possibility of completely disinfecting the cut edges immediately after the section by preventing their slipping back. Lauenstein's objection that they necessitate removal of additional sound tissue is hardly a disadvantage, as a prospect of a permanent cure is thereby increased. As to other disadvantages, Kocher is convinced that they cause no necrosis if the operation be properly and aseptically performed. He has no hesitation in applying a clamp to the healthy part of the duodenum where it is afterwards to be stitched. In his use of clamps, Kocher applies no elastic covering after the manner of Gussenbauer, nor does he use the elastic bands of Rydygier. He merely clamps them firmly enough to thoroughly close the intestine and stomach, and has observed that the edges of both bleed actively as soon as the clamps are removed. Finally, Kocher denies that the clamps, by requiring unnecessary room, necessitate a needless separation of the mesentery, as stated by Lauenstein.

The results which Kocher and others have obtained with his method are very good as regards the low immediate mortality, the restoration of function, and the prolongation of life; but this operation is not applicable for all cases, especially now that it has become generally recognised to be necessary to resect more freely towards the cardiac orifice. As in all intestinal surgery, there must be no tension upon the suture line, but if the duodenum be mobilised as described by Kocher (p. 474), it can be joined to the remainder of the stomach after a fairly wide resection; but the surgeon's primary duty is to resect freely enough, and the method of anastomosis is a matter of comparatively slight importance, which must not be allowed to have any influence on the extent of the resection to be adopted in any given case. A surgeon who slavishly attempts to apply Kocher's method of joining the duodenum to the stomach in all cases will sometimes either remove too little of the stomach, or court disaster by joining parts under tension.

II. Pylorectomy with Suture of the Divided Ends (the first method of Billroth). Direct union of the divided ends has little to recommend it, and it is only mentioned here for its historical interest.

When it is possible to bring the parts together without tension, it is better to adopt Kocher's method of gastro-duodenostomy, for the mortality of the latter operation is much lower. Guinard (quoted by Kocher *loc. cit.*, p. 211) analysed the result of 291 resections performed between 1891 and 1898, and found the mortality of 148 operations performed by Billroth's first method to be 37·8 per cent., whereas only 15·64 per cent. of deaths resulted from 64 operations after Kocher's method. Maydl, however, only had a mortality of 16 per cent. in 25 resections by Billroth's first method. The operation takes a long time on account of the difficulty of the suturing. Leakage very frequently occurred at the angle of junction of the anastomosis and the gastric wound—"the fatal suture angle" of Billroth. Paterson (*loc. cit.*) found that leakage had occurred in 35 per cent. of 59 cases collected by him; whereas the catastrophe only happened in 3 out of 79 cases of lateral anastomosis, and Kocher in 84 resections by his method "lost only one patient from leakage at the line of union." This grave

risk may be partly avoided, and time saved, by using a bone bobbin, as recommended by Mr. Mayo Robson, but in many cases of wide resection the divided ends cannot be brought together without undue tension. Ulceration and obstruction has occurred at the line of union, as in a case under the care of Mr. Bruce Clarke, quoted by Mr. Paterson.

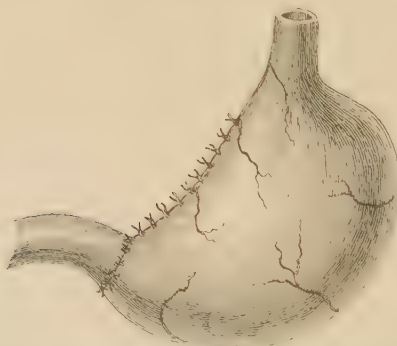
III. Combined Resection and Gastro-jejunostomy (Billroth's second method). This method, the adoption of which is becoming

FIG. 185.



Resection of the pylorus. (After Billroth.) The lower end of the line of section, *b*, should be a little more to the left. In Billroth's original operation both the stomach and the duodenum were divided nearer to the growth,

FIG. 186.



Duodenum united to the greater curvature. (After Billroth.) This method of union is so apt to be followed by leakage at the angle of the suture line that it has been almost universally discarded.

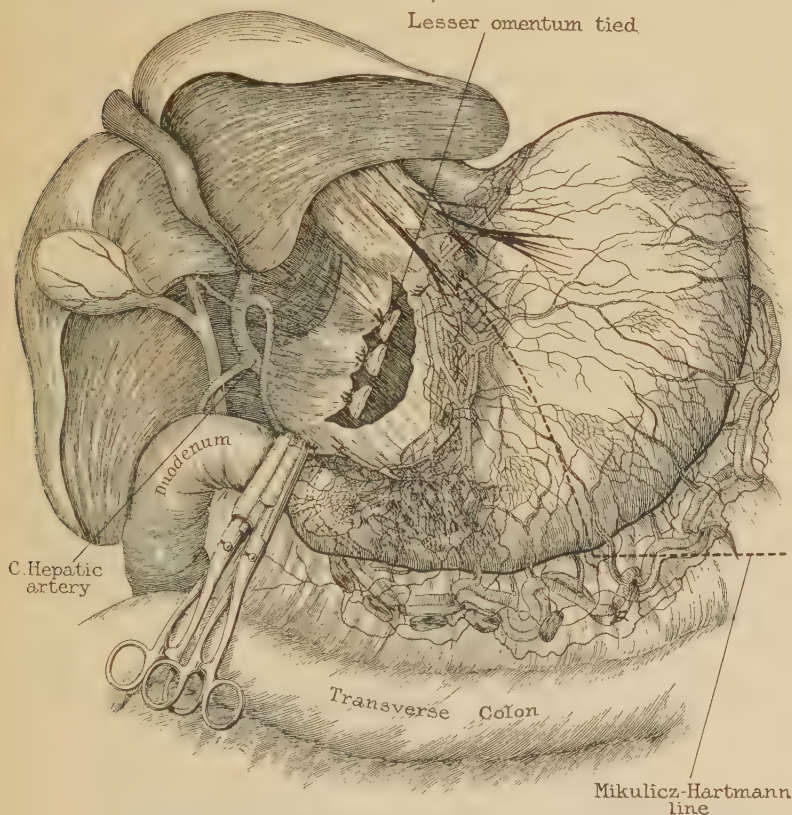
more and more general, bids fair to become the recognised method of removing growths of the pyloric third of the stomach. The chief advantages are:—

(1) Great rapidity and simplicity, especially if the anastomosis be made with a Murphy's button, but this ingenious contrivance should not be resorted to except when there is great need for hurry, for the anastomosis is neither so safe nor so likely to remain patent as the one made by the direct suture method.

(2) It is as easy to remove a considerable portion of the stomach as to excise the pylorus only; hence the surgeon need run no risk of not removing the growth widely enough.

(3) The anastomosis is made between healthy uninjured parts, which are under no tension. It should be remembered, however, that this

FIG. 187.



Showing the lesser omentum tied well above the stomach and lymphatic glands, and the lines of division of the stomach and duodenum. (After Mayo, *Ann. of Surg.*)

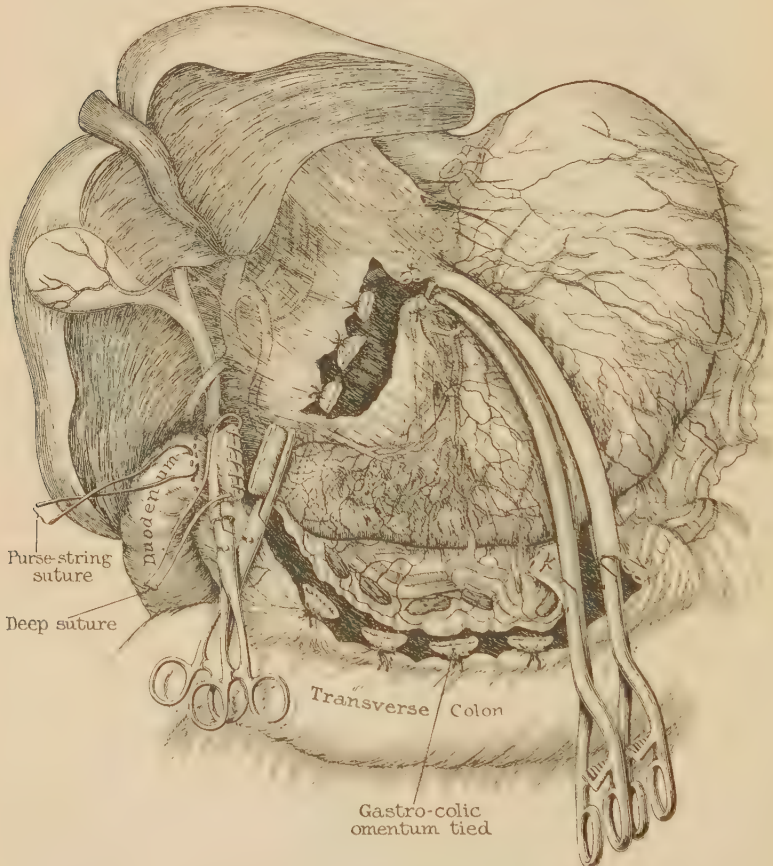
method has some of the possible, if diminishing, disadvantages of gastro-jejunostomy for other causes; and these have to be guarded against (p. 502).

The following description of the operation is largely taken from Dr. W. J. Mayo's valuable contribution upon this subject (*Ann. of Surg.*, 1904, vol. xxxix, p. 321). Dr. Mayo does not claim that the operation, as he performs it, is in any sense original. It is a composite operation, based upon the labours of Billroth, Kronlein, Mikulicz, and Hartmann, and upon the researches of Cuneo into the lymphatics of the stomach (*vide* Fig. 185, p. 480).

Operation.—"A small incision is made in the median line, half-way between the ensiform cartilage and the umbilicus; through this two fingers are introduced for exploration. If the condition is inoperable,

the incision is closed, and a sufficient number of buried non-absorbable mattress sutures of silk, linen, or wire introduced into the aponeurotic structures of the linea alba to enable the patient to get about at once and to return to his friends within a few days. If sutured in the usual manner, and the patients placed in bed for two or three weeks, many of them will develop hypostatic pulmonary lesions, loss of appetite,

FIG. 188.



Showing the clamps in position, the gastro-colic omentum tied below the lymphatic glands. The duodenum has been severed, and is being occluded by means of two sutures. (After Mayo, *Ann. of Surg.*)

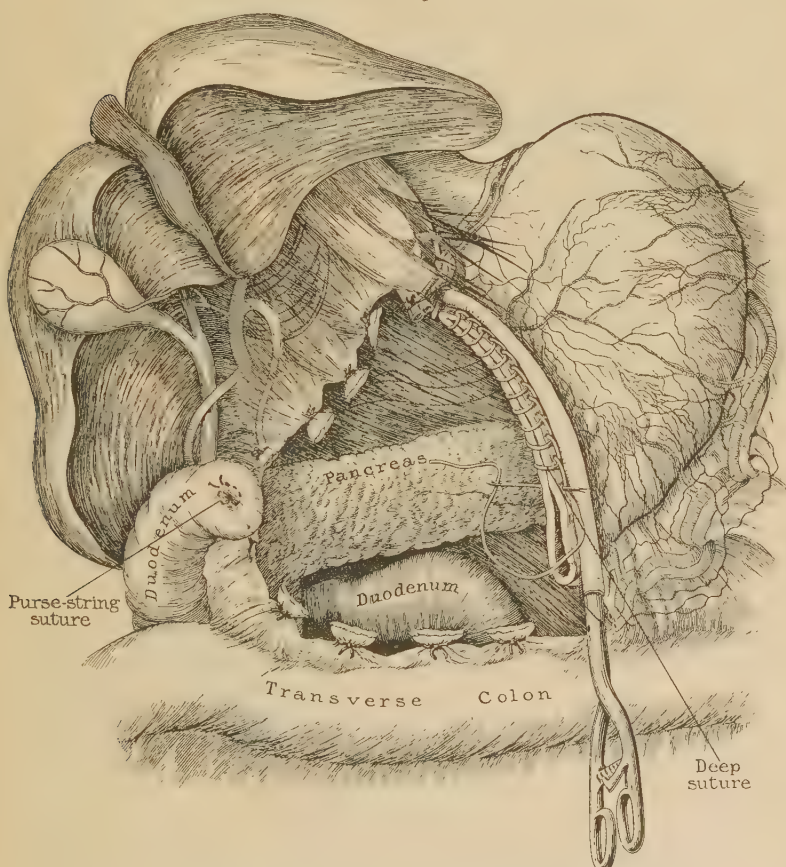
swelling of the feet, and general debility, and may be unable to spend their few remaining days at home. When an advanced cancer case goes to bed for a week or two, the chances of his getting about again are small."

If the growth is removable, the incision is enlarged to four or five inches, and the gastro-hepatic omentum is at once tied and divided to the extent shown in Fig. 191.

This at once increases the mobility of the growth, and allows gauze packs to be introduced behind it for the isolation of the field of operation, and prevention of any soiling of the peritonæum. The gastric

artery is severed between two ligatures, where it joins the lesser curvature, about an inch below the cardiac orifice. The gastro-duodenal artery or the right gastro-epiploic is tied near the pylorus, and the left gastro-epiploic is secured opposite the line of section of the stomach; the pyloric artery is also tied and divided between two ligatures. By securing these vessels quite early the operation is rendered almost bloodless, and collapse is very considerably diminished. The gastro-

FIG. 189.



Showing the occluded end of the duodenum and the introduction of the first row of gastric sutures. (After Mayo, *Ann. of Surg.*)

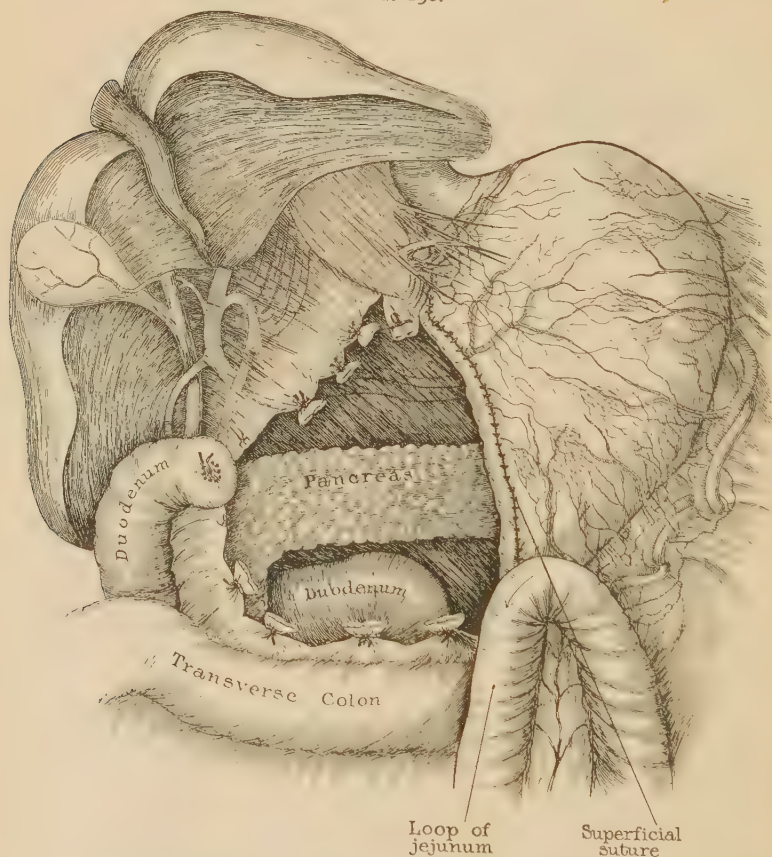
colic omentum is tied and severed to the necessary extent. "It is important that, in ligating the gastro-duodenal vessel and the gastro-colic omentum, the fingers should raise the structures away from the middle colic artery, which runs immediately beneath in the transverse mesocolon." Failure to take this precaution may lead to gangrene of the transverse colon, which has happened many times, as pointed out by Kronlein.

"The duodenum is doubly clamped and divided between with the actual cautery to prevent inoculation of the cut surface with cancer.

The duodenal stump should be left one-fourth of an inch long, and, before removing the clamp, a running suture of catgut is introduced through the seared stump and tied as the clamp is removed. A purse-string suture of silk or linen three-quarters of an inch below the stump enables inversion in a similar manner to the stump of the appendix (Figs. 192, 193).

"A long Kocher's holding clamp is now placed from the tied gastric

FIG. 190.



The operation is completed. (After Mayo, *Ann. of Surg.*)

artery at Mikulicz's point of election in an oblique direction, so as to save as much as possible of the greater curvature, to Hartmann's point of election in the greater curvature (Fig.) 192.

"The blades of this clamp should be covered with rubber tubing, and the compression should be just sufficient to hold the tissues in its grasp. A second clamp is applied on the tumour side to prevent leakage. The tissues between are severed with the Paquelin cauterizer one quarter of an inch from the holding clamp; and as the tissues are divided several catch forceps are caught on the projecting stump to prevent retraction of some part of the gastric wall from the grasp of the Kocher

clamp. The pyloric end of the stomach, with the tumour guarded against leakage by the clamp at each end, is removed. The cauterised stump projecting beyond the Kocher clamp is rapidly sutured with a catgut buttonhole suture from the greater to the lesser curvature through all the coats of the stomach, and in the same manner directly back, and tied at the starting point; this prevents hæmorrhage as well as leakage.

"The doubling of this form of suture holds the approximated edges evenly in line. The Kocher clamp is now removed, and any bleeding point caught and tied. The final suture is now introduced, of silk or linen, and made after the right-angled plan of Cushing. It is taken sufficiently far from the catgut-suture line to enable easy approximation of the sero-muscular layers without tension.

"Some of these steps can be varied sometimes with advantage.

"We have frequently tied off the gastro-hepatic ligament and the superior vessels, and at once double-clamped and divided the duodenum. By pulling upward on the stomach side the gastro-duodenal artery is easily caught, tied, and divided, and the operation proceeded with as before. In a few cases we have begun on the stomach side, ligating and dividing the gastric and left gastro-epiploic vessels first, then clamping, dividing, and suturing the stomach as before. This is favoured by Hartmann. If there are adhesions, however, the first plan mobilises the stomach much better, and enables more accurate work and greater exposure of that part of the stomach which at the line of section lies naturally deep under the costal arch."

Gastro-jejunostomy is then performed by one of the posterior suture methods (*vide* pp. 506 and 512).

Mayo performs the anterior button operation to save time in bad cases, but I should not expect the button to be quite safe in such cases.

The gauze packs are removed and all bleeding points ligated. Drainage is only occasionally used, on account of some accidental soiling; a cigarette drain is then passed just above the transverse colon, but not near the suture lines. The other end of the tube is fixed at the lower angle of the wound. Generally the abdominal wound is completely closed.

Drs. W. J. Mayo and C. H. Mayo have performed 100 resections, with a mortality of only 14 per cent. The duodenal orifice can be more quickly closed by ligaturing its extremity after crushing it with Doyen's angiotribe, and then inverting the tied end by means of a pursestring suture.

Paterson (*loc. supra cit.*) performs gastro-jejunostomy at the beginning instead of at the end of the operation, so that the anastomosis may not be done hurriedly, and in order to allow time for freezing and examining a small piece of the supposed growth. Should the mass prove to be innocent, resection may be avoided. The microscopical examination need only take about five minutes. It may be objected that posterior gastro-jejunostomy limits the mobility of the stomach so much that resection becomes more difficult, and that hurried examinations of peripheral parts of the growth or of the lymph glands would be unreliable, for the section may only show inflammatory changes that surround a growth. Moreover, the resection may disturb the anastomosis, although any fault in this may perhaps be recognised before closing the abdomen.

The After-treatment. — Shock is treated by warm rectal or subcutaneous saline infusions, warmth, subcutaneous injections of strychnine or aseptic ergot. Morphia should be given if pain is so severe as to prevent rest and sleep. The patient should be placed in the semi-sitting attitude of Fowler, for this diminishes the risk of pulmonary complications and facilitates drainage of the stomach, thus lessening vomiting. It also aids drainage of the lesser peritonæal sac in those cases which require it.

Rectal feeding should be adopted from the beginning, and continued until sufficient nourishment can be taken by the mouth. Soon after the patient has come round from the anæsthetic, tablespoonfuls of hot water may be given by the mouth to quench the thirst; after about twelve hours' small feeds of peptonised milk, and other liquids may be given every hour if they are retained. A small amount of food given by the mouth is worth a great deal more than nutrient enemata. In some cases, where vomiting is troublesome and persistent, continuous or repeated subcutaneous infusion should be adopted, and half an ounce of olive oil may be given subcutaneously night and morning, as recommended by Dr. Hale White.

TOTAL GASTRECTOMY.

Removal of the whole or very nearly the whole of the stomach has now been successfully practised a number of times by different surgeons.

The operation is indicated when it is found, on abdominal exploration, that the stomach is infiltrated with cancer, but that extensive adhesions and secondary deposits, either in other organs or in the lymphatic glands, are absent.

Connor, of Cincinnati, was the first to perform this heroic operation in 1883, but his courage was not rewarded, for the patient died upon the table.

Schlatter, of Zurich, was the first to perform the operation successfully in 1897.

Paterson (Hunterian Lectures, 1906), has "collected 27 cases of total gastrectomy for malignant disease. Of the 27 patients 10 died and 17 recovered, a result surprisingly good considering the extent and severity of the operation."

Mr. Paterson has ascertained the subsequent history of all except two of the 17 patients who survived the operation. Five of the patients have died, but the average duration of their lives after the operation was nineteen months. "Dr. Brookes Brigham's patient is at the present time in perfect health, eight years after the operation. Dr. Macdonald's patient is also alive and at work as a farm labourer, although seven years have gone by since his operation."

Six of the patients are still living and well six years after the operation, and three are well five years after it.

Paterson collected 20 cases of subtotal gastrectomy, with 14 recoveries. Of those patients who recovered from the operation 7 are now dead, the average duration of their survival being twenty-two and a half months, 5 died from recurrence, 1 from heart disease eleven years after the operation, and 1 from intestinal obstruction, without any recurrence. "Of the remaining 6 patients 1 was alive five and a half years

after the operation, 1 four years, and 1 three and a half years, after the operation."

It must be remembered that these results have been attained by surgeons of unusual experience, and that the mortality of 36 per cent. for total gastrectomy and 30 per cent. for subtotal gastrectomy does not represent the risk of these operations, many of which, being unsuccessful, have not been published.

As regards the method of operating, the plan most usually adopted is to remove the diseased area, as described above, and then to join a loop of jejunum to the œsophagus or remnant of stomach. The œsophagus has also been joined to the duodenum, but this is neither so easy nor so safe, owing to the difficulty of mobilising the latter sufficiently without interfering seriously with its nutrition; the jejunum can be joined without tension.

Mr. Mayo Robson (*Diseases of the Stomach*, 1904) found flexion of the head valuable in making the œsophagus more accessible, and he derived much help and guidance from an œsophageal tube. The patient died of shock. Simple suture is to be preferred in making the anastomosis, but if this is not practicable at the great depth of the wound, Murphy's button or Mayo Robson's bobbin may be adopted.

In a very successful case operated upon by Dr. Harvie of New York (*Ann. of Surg.*, March, 1900, p. 344), the duodenum and œsophagus were united by direct suture.

The patient was a woman, aged 46, who had had gastric symptoms for eighteen months before operation. On examination a rounded tumour could both be seen and felt. The operation was rendered difficult by adhesions both in front and behind the stomach, practically the whole of which was infiltrated and thickened. The entire stomach was removed, and the cut surfaces of the œsophagus and duodenum united by means of sutures. "The entire time consumed, from the first incision until the abdomen was closed, was one hour and five minutes. There was little or no loss of blood." The subsequent progress was most satisfactory, nourishment being first given by the mouth on the eighth day. The patient left the hospital six weeks after the operation, "after taking a dinner consisting of roast beef, mashed potatoes, ice-cream, cup of coffee, and one glass of milk."

GASTRO-JEJUNOSTOMY.*

The object of this operation is to make an opening between the obstructed stomach and the small intestine as high up in the latter as possible, so that the food may still find its way into the intestine and there meet with the other digestive fluids.

Although this operation is a very valuable one in suitable cases, it is necessary to protest against its indiscriminate use and abuse. There are some who seem to think that gastro-jejunostomy cures all the ills that the stomach is heir to; and from the writings of others we may

* To be accurate, the term gastro-jejunostomy should be used for union of jejunum to stomach, gastro-duodenostomy for union of duodenum and stomach (pp. 473 and 481). The term gastro-enterostomy, which has been carelessly used for either of the above operations, should be dropped. In future, writers should specify which operation they refer to.

indeed wonder, with Porter,* that we are not born with a gastro-jejunosomy.

Let us not forget that the stomach and duodenum have their uses in digestion and absorption, and that we ought not to endeavour to prematurely empty the one or to occlude the other without due consideration, unless there is definite pyloric obstruction, for which short-circuiting is of undoubted value. There are other indications which will be discussed in detail. It has been frequently stated of late that gastro-jejunosomy is almost devoid of danger; but this is far from true, although it may be almost safe in the hands of a few experts, if the patients are almost normal in their general health, but the operation has often to be performed under very different circumstances from these. It is certain that many gastro-jejunosomies are now performed unnecessarily, and it is just as certain that many others are deferred until it is too late. The statistics of the former are too favourable, and those of the latter are too unfavourable; the truth lies between them. Further, the late results of gastro-jejunosomy are not so very good as some would have us believe, although they should certainly improve in future.

It is necessary to refuse the operation in late cases of growth, and particularly in all cases of gastric neurosis, and to perform the gastro-jejunosomy, for the crises of locomotor ataxy can only be due to gross carelessness in diagnosis. That this and similar mistakes should have been made only emphasises the fact that this valuable operation is in considerable danger of being too frequently and lightly undertaken.

Indications.—It may be made use of (A) *in malignant disease of the stomach or duodenum under the two following conditions chiefly:*

i. *Together with pylorectomy or partial gastrectomy* (p. 486).—This is always to be preferred to an end to end union. This combination of operations has given good results (p. 495); it enables us to attempt the removal of the disease, and at the same time greatly shortens the operation. A very thorough examination should precede the operation.

ii. *Alone.*—This is clearly a very inferior operation to those of pylorectomy or resection and gastro-jejunosomy combined. If all the cases of gastro-jejunosomy which have been performed had been published, it is practically certain that the results both as regards the immediate mortality and the duration of life would be most disappointing. This is no doubt due to the fact that the operation has been far too often performed in very emaciated patients, quite unfit to bear a prolonged operation and to supply the necessary plastic repair. For the future gastro-enterostomy, or, as it should be here more correctly called, gastro-jejunosomy, should be reserved for the following cases of pyloric cancer: (1) where the malignant disease extends too far into the stomach, especially along the lesser curvature, or where it is too fixed—*e.g.*, to liver or pancreas—to make either a pylorectomy, or a partial or complete gastrectomy, justifiable, or where secondary deposits and fixed enlarged glands can be felt; (2) where the cachexia

* *Ann. of Surg.*, vol. xlv. p. 901. Dr. Porter gives many reasons for believing that gastro-enterostomy is not a harmless operation, and his article is well worthy of careful consideration.

and emaciation* of the patients are not so marked that it is very doubtful whether they will survive an operation that necessitates the handling of very vital parts, and for its success entails a certain adequate amount of plastic repair. The risks of pulmonary and other complications in these late cases must also be remembered.

These marasmic patients also suffer much more severely from shock than those with non-malignant disease, although the operation may be very quickly performed.

If the operation be carefully reserved for the above cases it will be called for less frequently than of late years, but will be found in these to give great relief and to prolong life for some months. If surgeons continue to perform it, as gastrostomy has been too often performed for malignant diseases of the œsophagus, in cases where the operation comes too late, their patients, if they survive, will do so for a very short time, succumbing to the effects of a marasmus so established as to be unalterable.

Gastro-jejunostomy is worse than useless when the growth does not cause obstruction of the pylorics and stasis of the gastric contents.

Recent improvements in the technique of the operation have greatly reduced its mortality even in malignant disease.

Dr. W. J. Mayo (*Ann. of Surg.*, 1905, vol. xlii., p. 642) states that he and his brother, Dr. C. H. Mayo, had performed in all 114 gastro-jejunostomies for malignant disease, with 21 deaths, a mortality of 18 per cent. Of these 114 cases 63 were in connection with pylorectomy or partial gastrectomy, with 8 deaths (13 per cent.). The very unfavourable cases of cancer obstruction were subjected to gastro-enterostomy, so that this operation gives a higher mortality than radical excision. In the last 40 gastro-jejunostomies for malignant disease the mortality was 8 per cent.

Mr. Moynihan (*Clin. Soc. Trans.*, 1901, vol. xxxix. p. 84) had performed gastro-jejunostomy for malignant disease 35 times between 1897 and July, 1905, with 5 deaths, or a little over 14 per cent. The first 7 operations were anterior, and the Murphy button was used, with 2 deaths. The last 28 were posterior suture operations, with only 3 deaths.

The average mortality for all cases by all operators is certainly a great deal higher than is indicated by the figures given by these brilliant surgeons, of unusual experience in this branch of surgery. It is probably nearer 30 per cent. This is largely due to too much delay in operating and want of courage to refuse to perform the operation in hopelessly late cases, and to the too frequent use of the Murphy button.

It is to be hoped that with earlier exploration and diagnosis gastro-jejunostomy will be replaced to a greater extent by resection, although many patients will always present themselves so late that only a

* Instances which do and which do not justify gastro-jejunostomy would be cases where, on the one hand, the loss has been only two pounds in several months, and, on the other, that of a stone in a week or two. In 12 out of 98 cases collected by Dr. Ticehurst (*loc. infra cit.*), the patients had lost more than a stone a month, and 7 of these died from the operation, and out of 23 others, in which the wasting was very considerable, 10 died.

palliative gastro-jejunostomy can be performed. At present many come too late even for this.

(B.) In certain non-malignant diseases of the stomach and duodenum.

I. In most cases of pyloric stenosis, especially when there is great dilatation of the stomach, much thickening of the pylorus, extensive adhesions or active ulceration. When the stomach is greatly dilated, posterior gastro-jejunostomy with a large opening provides far better drainage than any pyloric operation.

II. In chronic ulcer of the stomach or duodenum, causing severe and recurrent hæmorrhage, in spite of careful and thorough medical treatment. For the large majority of surgeons, if not for all, it is never wise to perform gastro-jejunostomy during the progress of severe gastric hæmorrhage (*vide* p. 460).

III. For chronic or relapsing ulceration of the stomach or of duodenum after medical treatment has been thoroughly tried and has failed.

Mr. Paterson in his valuable Hunterian Lectures (*Lancet*, 1906, vol. i. p. 500) concludes that "the mortality from gastric ulcer treated medically is at least 20 per cent., and further that at least 50 per cent. of the so-called cures relapse, while probably not more than 25 per cent. of the patients treated medically are really cured. On the other hand, gastro-jejunostomy holds out an almost certain prospect of cure, the proportion of relapses being probably no more than 10 per cent. The immediate risk of the operation is about 3 per cent., to which may be added the risk from septic jejunal ulcer, under 2 per cent."

Paterson formulates the principles on which to act as follows:—"If after six weeks' complete rest on a milk diet, a further period of six weeks on a milk diet with comparative rest, followed by three months' careful dieting, the patient is not free from definite symptoms, or if, after apparent cure, the patient has a relapse, operation is probably in the best interest of the patient. The symptoms, however, must be clear and definite."

Dr. Hawkins and Mr. Nitch (*Trans. Royal Med. and Chir. Soc.*, Nov. 2, 1906), in a review of 556 cases of gastric ulcer and its sequelæ admitted consecutively into St. Thomas's Hospital, found the mortality to be 13 per cent. These figures include 419 cases of simple ulcer, with 5 deaths, 1·2 per cent., 4 from hæmorrhage and 1 from exhaustion. The remaining 137 patients were admitted for complications and sequelæ, and 69 of these died. Dr. Hawkins and Mr. Nitch point out that 75 of these 137 patients were admitted "suffering from a perforation of a chronic ulcer, or the results of long-standing ulceration, such as gastric adhesions and pyloric stenosis, with long histories of gastric disease, often amounting to several years. The aim of treatment is to abolish this class of chronic ulcer." Forty-seven gastro-jejunostomies were performed, with 11 deaths.

I venture to quote the following important and fair remarks which were made by Dr. Hawkins at the meeting of the Royal Medico-Chirurgical Society on Nov. 27, 1906:—

"If the plan of medical treatment is good, its duration is quite insufficient. There are difficulties, however, in its extension when we are

dealing with patients who have to work for a living, but there is a fair probability that the number of patients who enter into the chronic ulcer group might be reduced if the duration of medical treatment and dieting could be extended to a minimum of six months.

As regards surgical treatment, as a measure aimed at preventing the chronic ulcer, gastro-enterostomy is to be recommended. The question of gastro-enterostomy as a routine matter in all cases which either do not make a good recovery after medical treatment or, having made a good recovery, quickly relapse, turns entirely on the mortality rate which is to be expected from the operation itself, and on the efficiency of the anastomotic opening. There are thus two sides to the question. In the first place, we have the balancing of the risks to life. It is among these chronic ulcer cases (roughly 25 in every 100 patients) that the chief mortality of gastric ulcer arises. I think it may be accepted that at least nine of the twenty-five ultimately die from perforation or from sequelæ, and the remainder are crippled for some years. I believe that, though the mortality rate from the operation of gastro-enterostomy itself must be reckoned with, it is so low (and is likely to become lower) that on the score of risk to life the balance is greatly in favour of the operation. Our figures at St. Thomas's Hospital are too small to bear a conclusion. In forty-seven instances of gastro-enterostomy there were eleven deaths. Of these eight must be credited to disease, and three to the operation. But these cases are not wholly to the point, for they were mostly instances of cicatricial effects of chronic ulcer, in other words instances of the very conditions which the operation as here recommended is intended to prevent, and it must be remembered that in the cases under consideration the operation would be undertaken, as it were, in a quiescent interval as a preventive, and not as a curative, measure, under the best conditions, and at a selected time.

In the second place, there is the question how far gastro-enterostomy may be considered as truly preventive of subsequent trouble and as a really scientific method of treatment. In this respect I think the figures from St. Thomas's Hospital are satisfactory, the more so, in fact, because, as is stated above, they are not strictly applicable, the operations being designed mainly to relieve sequelæ rather than to forestall them. Of 33 cases of gastro-enterostomy I think 17 may be described as giving a good result after one to four years, five derived slight benefit, two no benefit, and nine were discharged apparently well, but the operation was too recent to justify a verdict.

Certainly in two points, the comparative rest to the stomach afforded by its early emptying and the shortening of the period of high acidity, the operation has everything to commend it, and I believe that this advantage comes equally into play both as regards the speedy healing of a chronic ulcer, and as regards the prevention of fresh ulceration."

When the profession realises how bad the results of the medical treatment of gastric ulcer are at the present time, and adopts more thorough and prolonged treatment along the lines laid down by Dr. Hawkins, Dr. Spriggs, and others at the discussion before the Royal Medical and Chirurgical Society in November and December, 1906, the mortality of this grave condition will be very considerably diminished. The results will improve still more, when medical men realise the

possibility and the importance of preventing the development of the sequelæ and most of the complications of gastric ulcer by advising early operation when medical treatment has been thoroughly tried and has failed to cure.

The average mortality of gastro-jejunostomy for gastric ulcer and its sequelæ is unfortunately still higher than 3 per cent., as given by Mr. Paterson. In the practice of a few surgeons of unusual experience of gastric surgery the death rate may be even under 1 per cent. Mr. Moynihan has had no deaths in the last 151 operations (*Lancet*, 1906, vol. ii. p. 1440), Drs. W. J. Mayo and C. H. Mayo (*Ann. of Surg.*, 1905, vol. 41, p. 641) had four deaths in their last 140 gastro-jejunostomies, and only one in the last 80. It must not be forgotten, however, that these surgeons have gradually acquired special skill and judgment, and especially that their fame enables them to get their cases earlier* than the average surgeon, who is very often not asked to operate until it is too late to hope for the excellent immediate and remote results that may be obtained by operating in time to prevent the late results and complications of gastric ulceration. The general health of these neglected patients has been undermined by years of malnutrition, and the local conditions are often too serious for complete recovery to be expected.

It is partly for these reasons that hospital statistics extending back for about ten years, and showing a mortality rate of about 25 per cent., should not be allowed to influence us too much when we are estimating the death-rate of gastro-jejunostomy as it should be performed for simple ulcer. These figures also include the early failures from errors and imperfections of technique. Many of the operations were performed for sequelæ that should become more and more uncommon in the future. On the other hand, the low death-rate given in the statistics of individual and brilliant operators gives a false idea of the safety of the operation, and operations performed without sufficient reasons give even a more erroneous impression, that gastro-jejunostomy is free of danger and can be undertaken lightly.

As at present performed for simple ulcer, its complications and its sequelæ, gastro-jejunostomy certainly has a higher mortality than 3 per cent.; and in hospital patients derived from the poverty-stricken districts of London the death-rate is far greater. Mr. Gask (*Lancet*, 1906, vol. ii. p. 1662) gives the following statistics from St. Bartholomew's Hospital: "From 1903 to 1905 16 cases were operated upon by gastro-jejunostomy for gastric ulcer, and two died, giving a mortality of 18 per cent." During the same period "19 cases were operated upon for fibrous stenosis of the pylorus. Of these four died as the result of the operation, giving a mortality of 21·05 per cent."

In private practice the results are much better, for the patients generally seek relief earlier, and are in better condition to undergo the operation.

It is probably true that the average mortality of gastro-jejunostomy for non-malignant disease, as now performed by surgeons of average skill upon hospital and private patients, is nearer 6 than 3 per

* This can be seen very clearly by studying the statistics which were brought before the Medico-Chirurgical Society in November, 1906.

cent.; but when the operation is undertaken for simple gastric ulcer, and not for recurrent severe hæmorrhage, or for pyloric stenosis or other sequelæ, the mortality should certainly be under 3 per cent. in the hands of aseptic surgeons of average skill and thorough practical knowledge of all the necessary details of technique which are essential to success.

Dr. Norman Moore and Dr. Hale White (*Royal Med. and Clin. Trans.*, November, 1906) have laid stress upon the fact that gastric ulcer is more serious in patients over 30 years of age and in men than in women; therefore an operation should be advised earlier in these than in young women.

In conclusion it may be stated that if definite symptoms of gastric ulcer do not disappear under a six month's course of thorough medical treatment, or if they soon reappear after the cessation of this treatment, gastro-jejunostomy is strongly indicated in order to prevent the development of a chronic ulcer, with its dangerous and crippling complications and sequelæ. In addition, an accessible and removable chronic ulcer may be excised in order to hasten the recovery and make it more certain, as well as to lessen the risk of the development of carcinoma.

It is often wise to operate earlier in poor patients, because of the great difficulties in the way of continuing medical treatment long enough to effect a cure. The older the patient, the more important is it to operate without avoidable delay. It should be added, however, that the operation should be performed by a good surgeon, otherwise the danger may be greater than by leaving well alone.

IV. Infantile Hypertrophic Stenosis of the Pylorus.—It is not yet certain whether pyloroplasty or gastro-jejunostomy is the best operation for this condition. The mortality of the former has been less in published cases; 14 deaths have occurred in 25 gastro-jejunostomies, and 3 fatalities in 9 pyloroplasties (Paterson, *Hunterian Lectures*, *loc. cit.*). The late results are probably better after gastro-jejunostomy than after pyloroplasty, and infinitely better than after pylorodiosis, which has a comparatively low immediate mortality. Most of these patients are in a grave condition at the time of the operation, and this accounts for the high death-rate from all three operations; it may be hoped that earlier recognition and resort to surgery in suitable cases will do much to improve the results. And the recent improvements in the technique of gastro-jejunostomy ought to improve the results of this operation very considerably even when due allowance is made for the marasmic condition of these infants.

It has been maintained by Mr. Clinton Dent* in his Hunterian Lectures that pyloroplasty is simpler, less severe, and safer than gastro-jejunostomy, and also that it is quite as efficient.

Mr. Paterson agrees "with Mr. Stiles that in principle gastro-jejunostomy is the better operation for the following reasons: (1) It is preferable to operate on normal than on morbid tissues. (2) Feeding can be commenced at once after gastro-jejunostomy, no small advantage in these cases, whereas in several of the cases of pyloroplasty the feeding has caused no little anxiety. (3) If the anterior operation be performed, it can be completed within twenty-five minutes, which is a little

* *Trans. Roy. Med. and Chir. Soc.*, vol. lxxvi. p. 481.

longer than the time required for pyloroplasty. (4) The incision need be no longer than that required for pyloroplasty; two and a half inches is quite sufficient. If the patient's shoulders be slightly raised there is no fear of the protrusion of intestine. (5) The remote results are highly satisfactory. We do not yet know that those of pyloroplasty are so good."

V. **Dilatation of the stomach** from obstruction of the pylorus or duodenum due to the contraction of adhesions or to the pressure of irremovable new growths of the pancreas, kidney, or gall bladder. The results of the operation for atonic dilatation, for gastropsois, and for gastric neuroses have been very unsatisfactory.

VI. **Hour-glass Contraction due to Contraction of a Simple Ulcer.**—The jejunum may be joined to the cardiac pouch, which is generally the largest. This will be sufficient unless pyloric stenosis coexists, which is not uncommon.

If the pylorus is constricted, the jejunum may be joined separately to both pouches of the stomach, as suggested by Weir and Foote, or gastro-jejunostomy may be combined with gastropsois or gastro-gastrostomy. This combination is attended with excellent remote as well as good immediate results.

On the other hand, gastropsois and gastro-gastrostomy by themselves are very apt to be followed by recurrence. Paterson in an able analysis of 92 cases of hour-glass stomach (*Lancet*, 1906, vol. ii. p. 503) found that 25 per cent. of the patients who had submitted to gastropsois either obtained no relief or suffered from relapse, and the same results had followed 30 per cent. of the gastro-gastrostomies.

In at least 3 cases the true nature of the condition has not been discovered at the operation, and the jejunum has been uselessly joined to the pyloric pouch. Kammerer has adapted Finney's operation to hour-glass contraction of the stomach (*vide* p. 469). In the rare cases of carcinomatous hour-glass contraction, the growth should be resected if possible.

VII. **Tetany of Gastric Origin.**—This is almost always due to pyloric stenosis, and should be treated by gastro-jejunostomy without delay. The prognosis after operation is not nearly so grave as used to be thought. Moynihan records 14 cases without a single death after gastro-enterostomy.

GENERAL CONSIDERATIONS.

Before describing some of the chief methods of performing the operation of gastro-jejunostomy, it is important to draw attention to certain points which are essential to all of them.

(1) The opening must be a large one, at least $2\frac{1}{2}$ to 3 inches long, for otherwise it may contract or even become closed, especially when the pylorus is not completely or only temporarily obstructed, as in certain cases of ulceration in the prepyloric region.

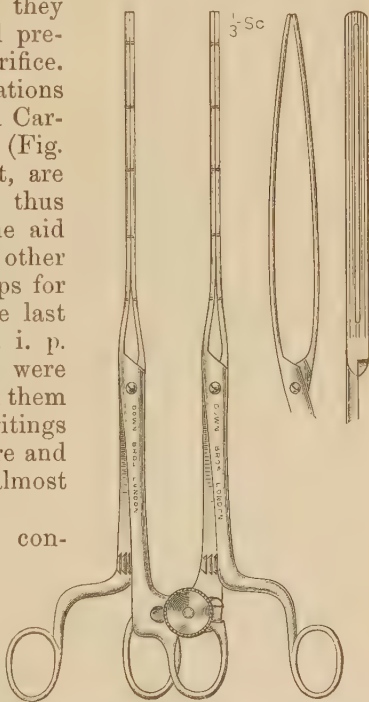
(2) The orifice must be placed at the lowest part of the stomach as the patient stands, for most of the food has to pass through the orifice during the day. There is much evidence to show that vomiting and recurrence of symptoms are largely due to malposition of the orifice. (3) Some of the mucous membranes of the stomach and

jejunum should be removed in order to prevent valve formation. An elliptical opening is thus made instead of a mere slit (Moynihan and Littlewood, *loc. infra cit.*). When the Murphy button is used, this plan is not necessary, for the button induces sufficient sloughing, but the size of the aperture made by a button which must be small enough to travel through the ileum is too small for satisfactory permanent drainage of the stomach. Moreover, it heals by granulation, and is therefore unusually liable to contract.

(4) **The Use of Clamp Forceps.**—Long slightly curved clamp forceps are invaluable for this operation, for they arrest hæmorrhage, prevent any leakage, and steady the parts during the operation; they also greatly facilitate the suturing and prevent purse-string contraction of the orifice. Mayo Robson's or Moynihan's modifications of Doyen's clamps are very good; and Carwardine's gastro-jejunoscopy clamps (Fig. 191), although the blades are straight, are excellent, for the two clamps lock and thus retain the parts in contact without the aid of an assistant. Doyen, Guinard, and other Continental surgeons were using clamps for this operation towards the end of the last century (Moynihan, *Lancet*, 1906, vol. i. p. 1856). Littlewood* and Moynihan† were amongst the first to use and recommend them in this country, and Moynihan's writings have done much to popularise them here and in America. Now their value is almost universally recognised.

(5) **Sutures.**—It is best to use a continuous catgut suture which pierces all the coats, and to reinforce this by a continuous sero-muscular suture of fine silk or Pagenstecher's thread. It is essential for the deep suture to pierce all the coats, so that it may not bite out before firm union has occurred, and lead to disastrous leakage. A continuous suture is far more quickly applied than interrupted sutures, and a continuous piercing suture controls hæmorrhage better than any other available means, and for this purpose the turns should not be more than one-eighth of an inch apart. Halsted's suture, although it is the most secure of the sero-muscular

FIG. 191.



Carwardine's clamps for gastro-jejunoscopy. The blades are longer than those of the intestinal forceps, and they are fenestrated to prevent slipping. The handles lock together, and thus automatically keep the stomach and jejunum in apposition.

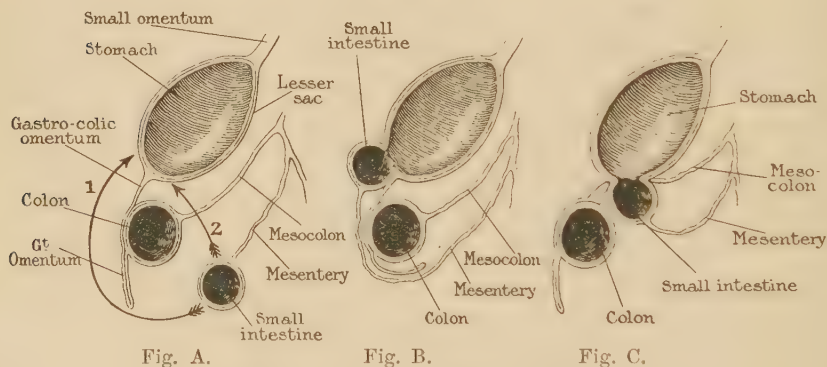
* Mr. H. Littlewood on "Intestinal Suture by Means of Continuous Catgut Stitch and Excision of the Mucous Membrane" (*Lancet*, 1901, vol. i., p. 1817); a paper read before the Leeds and West Riding Medico-Chirurgical Society on Oct. 19, 1900. The paper is illustrated, showing the use of Doyen's clamps for gastro-jejunoscopy.

† Mr. Moynihan (*Brit. Med. Journ.*, Dec. 9, 1900, p. 1631).

stitches, does not control hæmorrhage well, and several deaths from bleeding have followed its use. Moreover, it is not so secure as a piercing suture, and as it does not bring the mucous edges together properly, it is very apt to be followed by the formation of valvular folds of mucous membrane, which may obstruct the orifice unless this is very large. The deep suture may be either a circular (overstitch) or a mattress one; the latter secures better inversion towards the end, but is more likely to cause puckering unless properly applied. The knots should be upon the mucous surface, for leakage is less likely to take place than if the knots are tied upon the peritonæal surface.

The continuous Lembert or Cushing suture should be used to reinforce the deep one, and to secure wide serous apposition and union. The suture should turn in a little more of the serous surface

FIG. 192.



Gastro-jejunosomy shown diagrammatically.

Fig. A. The parts are here shown in their normal relations and attitudes. The arrow 1 shows the anterior operation after the method of Wölfler, that marked 2 the method of Von Hacker. Fig. B, anterior gastro-jejunosomy. Fig. C, posterior gastro-jejunosomy. It will be noticed that this provides the most dependent opening both in the upright and prone positions.

of the stomach than of the jejunum, so that the lumen of the latter may not be unduly narrowed or flattened.

Different Methods.—(1) *Posterior gastro-jejunosomy without a loop* (a) *with dislocation and reversion of the jejunum*, (b) *without dislocation and without reversion of the jejunum*; (2) *anterior gastro-jejunosomy*; (3) *posterior gastro-jejunosomy with a loop*; (4) *Roux's Y method*; (5) *anterior or posterior loop operations with entero-anastomosis*; (6) *operations with the insertion of mechanical appliances*; (7) *Mc Graw's elastic ligature method*.

The Choice of Operation.—It is not yet certain which of the many methods adopted at the present time is the best, and it is possible that better ways will yet be invented. The chief operations will be compared below as far as possible.

(1) *Anatomical and physiological considerations.*—If drainage of the stomach depends to any great extent upon gravity, it is clearly better to make the opening low down upon the posterior inferior surface than anywhere upon the antero-superior surface. This is true even

when the body is upright, and the advantage is greatly increased when the patient is recumbent (*vide* Fig. 192). But the weight of the long limbs of the jejunal loop used for the anterior operation certainly drags the anterior opening downwards to some extent. It must be remembered also that the stomach is not a passive bag, and that its drainage is not entirely dependent upon gravity. The larger the stoma, however, and the more damaged the muscular power of the stomach, the greater the advantage of securing a dependent opening. The results of the ingenious experiments of Cannon and Blake upon the healthy stomachs of animals are not strictly applicable to the diseased conditions which call for gastro-jejunostomy in man. Physiologically it is an advantage to make an opening high up in the jejunum, so that as little as possible of the small intestine may be lost for the purpose of digestion and absorption; but the researches of Paterson tend to show that absorption is hardly, if at all, diminished by anterior gastro-jejunostomy, in which the opening into the jejunum is lowest. It is of more importance to prevent the acid chyme reaching the jejunum too low down. Therefore, upon anatomical and physiological grounds, the posterior operation without a loop is better than any anterior operation, and it is more than probable that the posterior no-loop operation, without dislocation and reversion of the jejunum, is superior to all other methods of gastro-jejunostomy, because it interferes less with the normal anatomical and physiological conditions and relations. If anyone should still prefer to use a Murphy button the posterior operation is the best one to choose for it, for it falls into the stomach in at least a third of the anterior operations, whereas it is retained in the stomach after only about one-tenth of the posterior operations.

(2) *The anterior operation may be a little easier, more rapid, and may cause less exposure and perhaps less shock than the posterior no-loop operation, especially if performed by surgeons of little experience and skill, but the difference is small, and the time saved is trivial, for most of the time consumed in either operation is spent in actually making the anastomosis.*

A short or diseased mesocolon may occasionally make a posterior gastro-jejunostomy difficult or even impossible, and adhesions of the posterior wall of the stomach may very rarely do the same, but it is exceptional for growth or simple ulceration to affect the part of the stomach which is incised for posterior gastro-jejunostomy. When this part is affected, it is generally too late for the operation to be performed at all. A bulky great omentum may occasionally prolong and increase the difficulties of anterior gastro-jejunostomy.

The posterior no-loop operations are a little more difficult than either the anterior or posterior loop operations, but the difference has been greatly exaggerated. Personally I have not found the posterior no-loop operation without reversion of the jejunum to be more difficult than the loop operations. It has been stated that the jejunum may unduly fix the stomach in "no-loop" operations, but there is no real evidence of the validity of this theoretical objection. In one case in which the jejunum originated to the right of the spine, Munford (*Ann. of Surg.*, 1906, vol. xliii. p. 88) unfortunately performed the no-loop operation, with the result that the excessive tension led to separation and leakage at the suture line, but this case was, of course, unsuitable for the operation.

(3) *Severe Vomiting* (so-called "vicious circle").—The evidence upon this point is somewhat conflicting. Dr. Ticehurst collected 98 Guy's Hospital cases for his able thesis, which has been of great help to me. His cases and conclusions are of especial value, because the operations were performed by *many different surgeons* between January, 1899, and June, 1905, so that the facts and conclusions are not gathered from the published accounts of a series of operations by any one surgeon, which are too often misleading. In ninety-eight consecutive operations at Guy's Hospital, the anterior method was chosen twenty-four times. Out of ten cases of serious vomiting seven followed the anterior operation, and four of these died, whereas this complication only occurred three times after 64 posterior operations.

Mayo (*loc. supra cit.*), on the other hand, states that "vicious circle" occurred most commonly after the posterior loop method, owing to the liability of the comparatively short loop to kink. In fifty-three of these operations there were three deaths, but the primary result was good in the others. Seven of the remaining fifty, however, required a secondary operation for gradually developing symptoms of obstruction, with regurgitation of bile, &c.

Acute serious vomiting is more likely to follow the anterior operation, and it is probable that chronic or gradually developing vomiting is more common after the posterior loop operation. So far as the evidence goes, vomiting is rarer after the posterior no-loop operation than after any other method except that of Roux, which is too severe and tedious for general adoption. This and entero-anastomosis will be discussed later. It is probable that vomiting will be least common after Mayo's operation without dislocation and reversion of the jejunum, but enough data are not available to prove this theory. Mayo states that no death and no trouble occurred in his 63 cases operated upon by this method since July, 1905. If serious vomiting should occur, then it would be a disadvantage of this method that entero-anastomosis could not be easily performed for its relief.

(4) *Intestinal Obstruction*.—This has been a little more frequent after the posterior operation. Moynihan (*Lancet*, 1906, vol. i. p. 1345) mentions three cases in which the small intestine herniated into the lesser sac through the rent in the mesocolon. This accident should not occur again, for it can be prevented by sewing the edges of the rent to the jejunum or stomach. This orifice has also contracted upon the jejunum or upon the anastomosis, but this rare event is probably preventable by careful suturing, as above indicated. After the anterior operation the jejunal loop has compressed the colon, or *vice versa*, and in one of the Guy's Hospital series both the jejunum and the colon were obstructed by mutual compression, although the anastomosis was made twenty-four inches below the duodeno-jejunal flexure. The obstruction was so complete, that the intestine between the jejunal loop and the middle of the transverse colon was collapsed and almost empty. In one case quoted by Mayo the small intestine passed over the afferent jejunum, and became strangulated. Intestinal obstruction is very unlikely after the "no-loop" operations.

(5) *Mortality*.—The death-rate has been a little higher after the anterior operation, but this may be partly due to the almost exclusive adoption of this method in the early days of this operation, before

experience and skill were acquired, and to its selection in grave cases to save time.

In 19 malignant cases recorded by Ticehurst the anterior operation had a mortality of 53 per cent., whereas in thirty-one posterior operations for malignant disease the death-rate was 35 per cent. Dr. Murphy, Dr. Mayo, and most other authorities have found the mortality of the anterior operation to be a little higher.

(6) *Perforating Jejunal Ulcer*.—This has been far more frequent after the anterior operation, and after adding entero-anastomosis to any form of gastro-jejunostomy. Moynihan (*Lancet*, 1906, vol. i. p. 705), mentions 33 cases, in twenty-nine of which the nature of this operation is recorded. This grave complication followed seventeen anterior operations, four anterior with entero-anastomosis, one anterior Y operation, and six posterior loop operations with entero-anastomosis. Its occurrence seems to be chiefly due to the action of the over-acid chyme upon the jejunum low down, and especially to its action upon the part of the jejunum which is between the stomach and the intestinal anastomosis in the cases in which this plan is adopted.

Paterson (*loc. supra cit.*) also thinks that it indicates unsatisfactory drainage of the stomach, for hyperchlorhydria ought not to occur with efficient drainage.

(7) Posterior operations allow a more thorough examination of the posterior wall of the stomach.

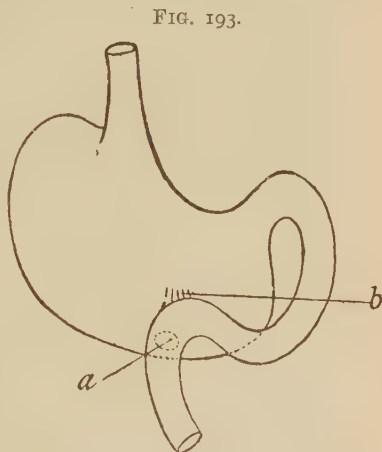


FIG. 193.
Von Hacker's operation from behind.
After Petersen (Mayo Robson, and Moynihan.)

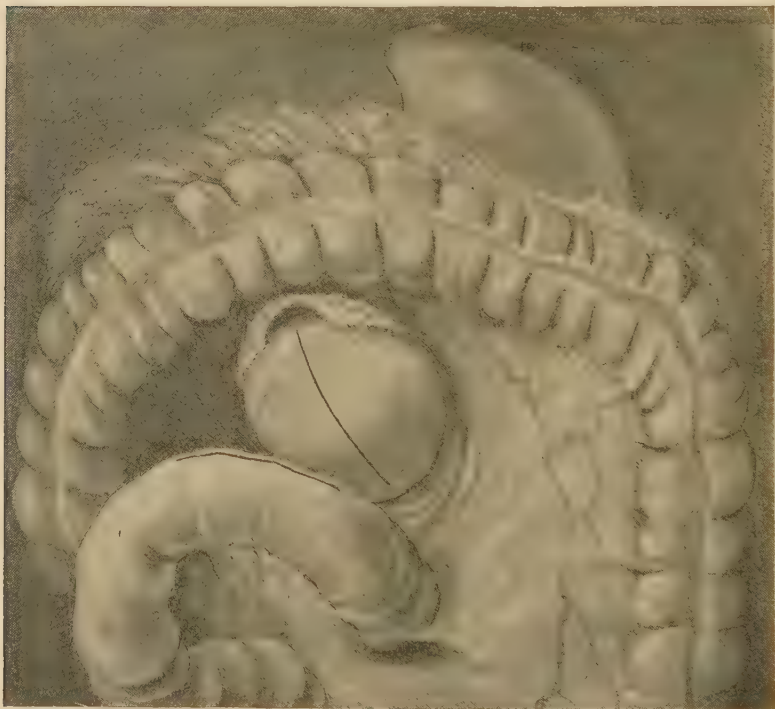
Mr. Basil Hall (*Lancet*, 1902, vol. ii. p. 657; *Brit. Med. Journ.*, Oct. 10, 1903) has tried to avoid the disadvantages of both anterior and posterior gastro-jejunostomy by joining a loop of jejunum to the posterior surface of the stomach through a rent in the gastro-colic ligament instead of through the transverse mesocolon. In my opinion this operation has nearly all the disadvantages of the anterior operation as enumerated above, although it should provide better drainage; it also has all the objections of loop operations (*vide supra*). Mr. Basil Hall records twelve successful operations which were performed as above indicated.

It may be concluded that the available evidence is considerably in favour of posterior "no-loop" operations. Therefore these operations are described first, and the procedures least recommended are described last.

Posterior Gastro-jejunostomy (Von Hacker) has been very considerably modified in recent years. Czerny performed the operation without a loop years ago, generally with the aid of the button and supplementary sutures, with great success. Dr. Rogers states that this operation has been performed 215 times for benign cases in Czerny's clinic, with only ten deaths (*Ann. of Surg.*, vol. xxxix. p. 512). Mikulicz used a transverse jejunal incision in performing the no-loop operation. The

advantages of avoiding a loop have become widely known from the writings of Petersen, and the operation has been greatly facilitated by the aid of clamp forceps. Mikulicz's method of making a transverse incision in the jejunum does not allow a large opening to be made, for it must be smaller than half the circumference of the bowel, otherwise it may lead to obstructive symptoms from kinking and valve formation. This happened in four out of forty-three of these operations recorded by Dr. W. J. Mayo, and four secondary operations had to be performed.

FIG. 194.



Posterior gastro-jejunostomy without a loop. (Dr. W. J. Mayo, *Ann. of Surg.*)

The posterior wall and greater curvature of the stomach, presenting through the rent in the mesocolon, are marked, showing the oblique line of incision of Moynihan. The jejunum has been turned over to the right; the site of the incision is marked. The clamps are applied parallel to and include the lines on the stomach and jejunum.

The opening from the stomach into the distal part of the intestine was successfully enlarged by performing Finney's operation (*vide* p. 469) on either side of the opening. It was impossible to make an entero-anastomosis on account of the shortness of the available intestine above the gastro-jejunostomy.

(A) Posterior Gastro-jejunostomy without a Loop, with reversion of the Jejunum.

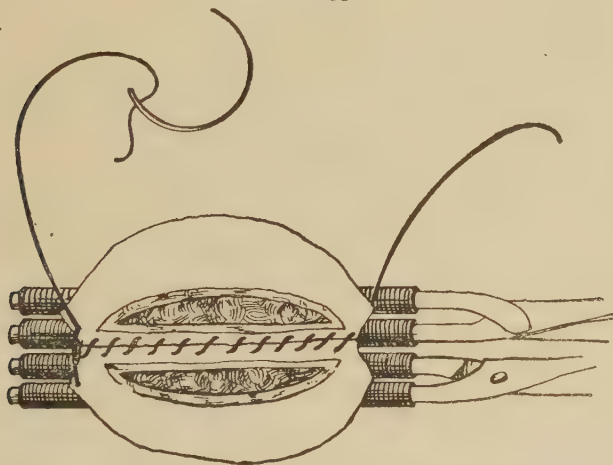
For the following account I am very largely indebted to Mr. Moynihan's excellent description of the operation which he has done so much to

improve, and he and others have used with such signal success.* Much of what follows is also based upon the brilliant work of the brothers Mayo.†

A vertical incision four inches long is made three-quarters of an inch to the right of the middle line, over the upper part of the rectus abdominis, and extending down to the level of the umbilicus. The rectus sheath is opened, and the muscle is freed and displaced outwards. The abdomen is then opened by incising the posterior layer of the fibrous sheath and the peritonæum in a line with the original incision, so that the deep part of the wound lies behind the rectus muscle when the latter is released. A valvular wound is thus obtained for the prevention of ventral hernia.

The stomach and the first part of the duodenum are thoroughly examined before deciding which operation, if any, to perform. The

FIG. 195.



Clamps side by side, the first line of suture. (Mayo Robson and Moynihan.)

great omentum and the transverse colon are drawn well forwards upwards and to the right, making the mesocolon taut, and bringing it well into view. A bloodless part of it is selected, picked up with forceps, drawn downwards and away from the stomach, and snipped with scissors.

The opening thus made into the lesser sac is carefully enlarged until it admits three fingers, and through it the posterior surface of the stomach is thoroughly examined.

That part of the greater curvature which lies lowest in the abdomen is selected for the site of the anastomosis. Mayo places his incision almost vertically below the cardiac orifice, well to the left of the more muscular pyloric third of the stomach. When the proper site has been noted, the left hand is used to push the posterior wall of the stomach through the rent in the mesocolon, care being taken to expose the actual lower border of the stomach, and about a quarter of an inch of

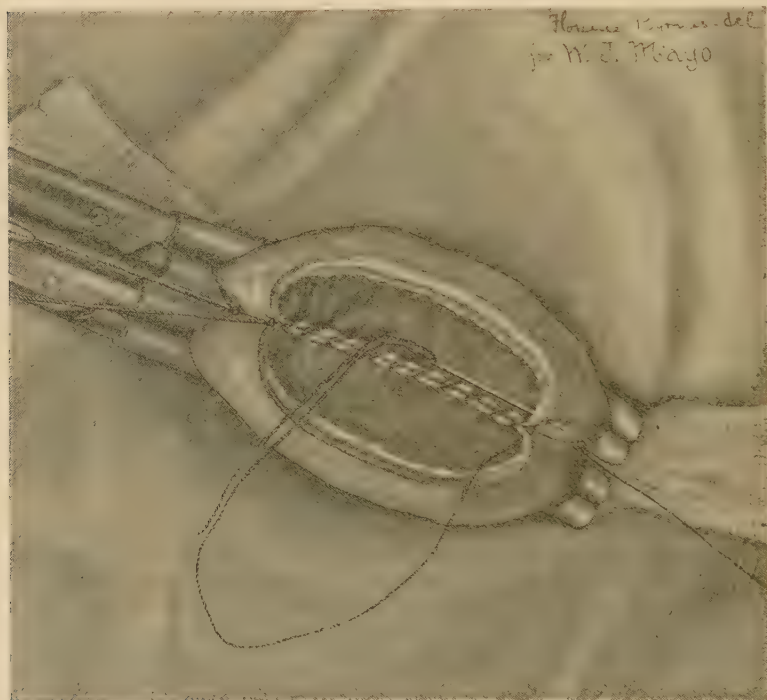
* Moynihan's *Abdominal Operations* (1906), p. 142.

† Dr. W. J. Mayo, *Ann. of Surg.*, 1905, vol. xlii. p. 641; *ibid.*, 1906, vol. xliii. p. 537.

the anterior surface also, by carefully displacing the gastro-colic omentum to the required extent. Long curved clamp forceps sheathed in rubber are then placed obliquely with their handles to the left and below, and their tips pointing to the right shoulder and meeting just in front of the lowest point of the greater curvature (Figs. 190 to 194).

The fold of stomach drawn into the clamp should be at least three and a half inches long.

FIG. 196.



Posterior gastro-jejunostomy without a loop. (Dr. W. J. Mayo, *Ann. of Surg.*)

The gauze packings under, between, and around the exposed pouches and clamps are shown. The forceps have their handles to the right. The first knot of the hæmostatic deep suture, which pierces all the coats, is best placed upon the mucous surface.

By drawing the transverse colon forwards and to the right, and passing the finger backwards and to the left along the under-surface of the mesocolon, the duodeno-jejunal flexure is easily found. The jejunum near its origin is turned towards the right, and brought into the wound. A fold of it three and a half inches long, including the free border, is clamped, the tips of the blades being about five inches and at the bases about one and a half inches from the duodeno-jejunal flexure.*

The protruding portions of the omentum, colon, and excess of

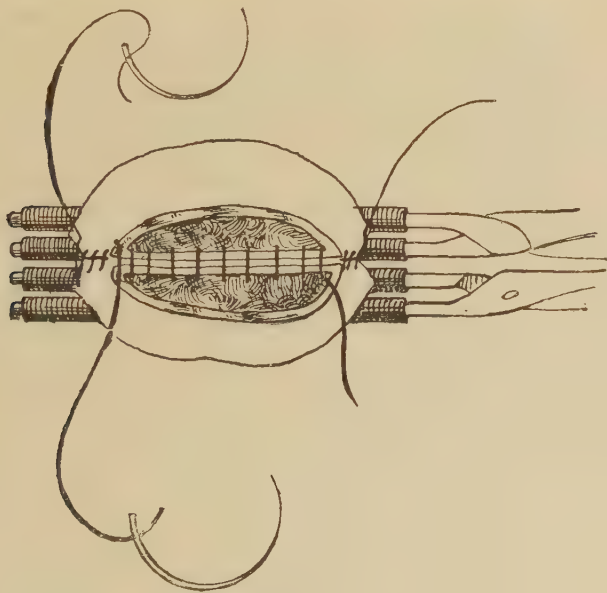
* Dr. W. J. Mayo prefers to place the forceps with their handles to the right, because it is easier to apply them, but it is an advantage for the handles to be held by an assistant who faces the operator. (*Vide* Fig. 196.)

jejunum are now returned into the abdomen, to avoid any possible contamination during the next stage.

With the same object a roll of gauze, moistened with hot normal saline solution, is now placed between the two clamps, which are afterwards closely approximated and held in apposition by an assistant standing opposite the surgeon. Carwardine's special gastro-enterostomy clamps can be locked, and do not need an assistant to hold them together (Fig. 191).

A continuous sero-muscular suture of thin Pagenstecher's thread or silk is now used to join the adjacent edges of the two viscera for a

FIG. 197.



The stomach and jejunum opened, the inner hæmostatic suture.
(Mayo Robson and Moynihan.)

distance of at least three inches. It is begun on the left, where the tail thread of the knot is held with forceps. The thread should be always held taut, to secure close approximation and to raise a fold of sero-muscular tissue after each stitch, which simplifies the introduction of the next one (Fig. 195).

When the first half of this superficial suture has been inserted, the serous and muscular coats of the stomach and jejunum are carefully incised, so as to expose and liberate the mucous membranes which pout into the wounds. An elliptical piece of mucosa, about two and a half inches long and over half an inch wide, is excised from the stomach and jejunum. The incision thus made should be a quarter of an inch in front of and parallel to the posterior sero-muscular suture line.

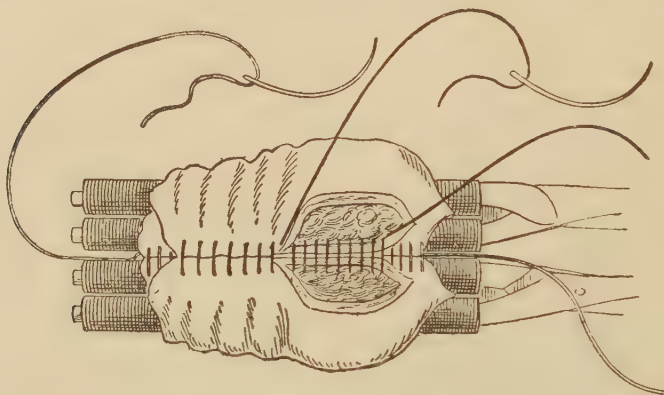
The gastric mucous membrane is prevented from retracting by means of tissue forceps, if necessary.

Reliable catgut should be used for the deep suture, which must pierce all the coats. It should be commenced at the right extremity

of the incision, so that the superficial and deep sutures may not have their knots and terminations close together (Figs. 196 to 198).

The knot is placed upon the mucous surface, and the tail thread is held with forceps. The suture is continued as a circular or over stitch

FIG. 198



Inner suture nearly complete. (Mayo Robson and Moynihan.)

as long as inversion of the edges can be easily made. As soon as any difficulty arises, the needle is passed after the method of Connell adopted by Mayo (*vide* p. 362, Fig 112 B). This is an excellent and rapid way of completing the suture. Both knots should be placed upon the mucous surface in the manner already described (*vide* p. 358, Figs. 105, 106).

FIG. 199.



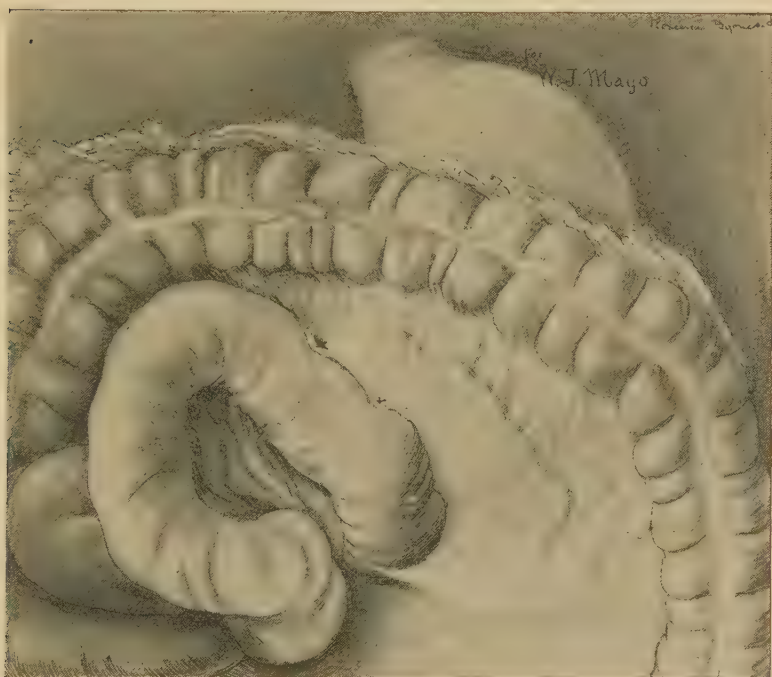
Clamps removed. (Mayo Robson and Moynihan.)

Care must be taken to keep the thread always taut, and the turns should not be more than one-eighth of an inch apart. These precautions secure accurate apposition of the mucous membranes, and especially prevent hæmorrhage. The clamps are now removed, and if the deep suture has been properly applied, very little bleeding occurs. The exposed parts are cleansed with moist sterile swabs. The

sero-muscular suture is now continued after the method of Cushing (Fig. 101), which leaves none of the thread exposed, and therefore lessens the chance of adhesions. The final knot is buried by reversing the direction of the last stitch, which should be placed beyond the knot at the starting point; the two ends are then tied together. The whole circle of union is now examined, and if necessary a reinforcing suture may be placed at any weak spot.

The gauze packs are removed and the parts cleansed. The transverse colon is brought out again, and drawn forward so as to expose the rent

FIG. 200.



Posterior gastro-jejunostomy without a loop. (Dr. W. J. Mayo, *Ann. of Surg.*)
The anastomosis has been completed, and the mesocolon has been sewn to the jejunum.

in its mesentery to enable the surgeon to fix its margins to the jejunum or stomach. Failure to do this may lead to the formation of an internal hernia. I have operated upon one patient in whom the anastomosed loop had been drawn into the lesser sac, and had become constricted by the contraction of meso-colic incision and the formation of adhesions.

Four sutures are sufficient, one in front, one behind, and two at the sides. Mayo uses mattress stitches, which are passed in such a manner that they turn the raw edges of the rent upwards into the lesser sac, so as to lessen the risk of adhesions.

Moynihan sews the edges to the jejunum, while most surgeons use the stomach for this purpose. The former plan is easier to adopt, and tends to prevent kinking of the jejunum (*vide* Fig. 200).

The viscera are replaced, and the abdominal incision is closed, the anterior rectus sheath being overlapped, as recommended by Winslow and Noble (*vide* Fig. 43, p. 103).

Mr. Moynihan has used this "no-loop" method in a great many cases without any trouble. Dr. W. J. Mayo (*Ann. of Surg.*, 1906, vol. xliii. p. 537) has, however, published two cases in which chronic bile regurgitation of a serious character developed. In each of these "the occasional regurgitation of quantities of biliary and pancreatic secretions was a source of great discomfort and considerable disability.

FIG. 201.



Posterior gastro-jejunostomy without a loop. (Dr. W. J. Mayo, *Ann. of Surg.*)

The position of the oblique posterior opening is shown diagrammatically, also angulation of the reversed jejunum.

Reoperation in both cases during the past summer (1905) showed that the cause of the trouble was an angulation of the jejunum at its gastric attachment." These troublesome symptoms occurred after two out of 56 "no-loop" operations performed between January 1 and July 1, 1905, with only one death.

(B) Posterior Gastro-jejunostomy without a Loop, and without reversion of the Jejunum (Fig. 202).

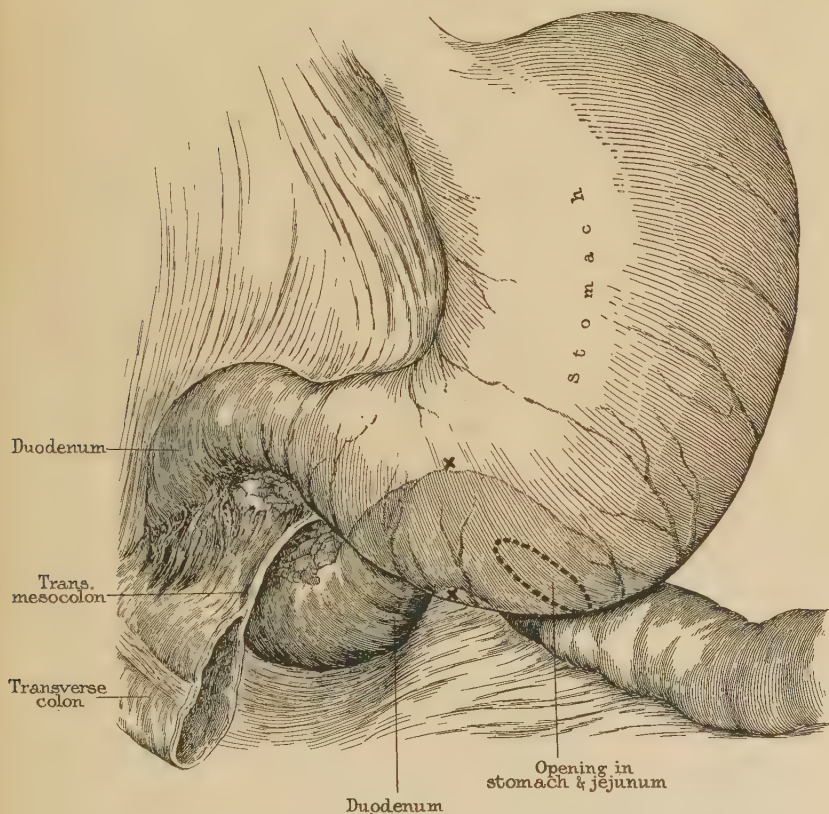
These cases led Dr. Mayo to doubt whether it is really necessary to reverse the direction of the jejunum so that it runs in the same direction as the stomach. Normally the jejunum ascends a little from its origin towards the left and then falls downwards, backwards, and to the left towards the left kidney pouch.

When it is fixed to the stomach in the usual way, it is rotated and

moved to the right, so that kinking may occur at the anastomosis, and the distal part of the bowel rides forwards and to the right over the prominence of the lumbar spine. The shorter the loop, the more likely the kinking; therefore this particular form of obstruction is most likely to follow the posterior loop operations.

The brothers Mayo were unable to find any valid reason for reversing the normal direction of the jejunum in no-loop operations, and they

FIG. 202.



Mayo's posterior gastro-jejunostomy without a loop and without reversion or dislocation of the jejunum. *xx* indicate the duodeno-jejunal flexure. (Mayo, *Ann. of Surg.*)

have therefore discarded it. Now they perform the anastomosis without disturbing the natural relations of the parts, and in the last 65 cases they have had no death and no trouble of any kind.

These results are very good as far as they go, but sufficient time has not yet elapsed to enable us to make important deductions from them. Now that we know that "vicious circle" is nearly if not always due to the unsatisfactory position and size of the stoma, there does not seem to be any reason for rotating and dislocating the jejunum, which probably drains the stomach better when it is left in its natural position.

This method certainly deserves a thorough trial. I have used it in six cases with the most satisfactory results, and I believe it to be the best method yet devised.

The only essential difference from the usual no-loop operation as described above is that the incision in the posterior wall of the stomach must run downwards and to the left instead of downwards and to the right, so that it may be parallel to the longitudinal incision made in the jejunum (*vide* Fig. 202).

Hence the stomach clamp must be placed at right angles to its usual direction, and the direction of the jejunal clamp must be reversed if their handles are still turned to the left. Mayo prefers to have the handles to the right, but it is more convenient that they should be on the left, where the assistant can hold them. The operation is not more difficult than the usual posterior operation with reversion.

(C) **Anterior Gastro-jejunostomy** (Wölfler).—After the stomach has been thoroughly examined the lowest part of the greater curvature is selected and exposed by detaching the gastro-colic omentum and its vessels from the stomach for about one and a half inches as recommended by Kocher. This procedure allows the stomach to be drained at the lowest point of the anterior surface. A few vessels may need tying.

Long curved clamp-forceps are applied obliquely with their handles towards the left shoulder, and their points below and behind the greater curvature. The fold included in the forceps should be three inches long.

The duodeno-jejunal flexure is found in the way already described (p. 508); and the jejunum is traced downwards for about fifteen inches, where it is clamped and joined to the stomach. It is important to actually follow the bowel from its origin. If the piece of small intestine which emerges below the colon be chosen, it may prove to be low down in the ileum. If the wrong end of the small intestine be thus attached to the stomach, the food taken will not be subjected to the natural processes of digestion and absorption and the prolongation of life will be brief. The importance of the above is proved by the fact that the above accident has occurred to operators of such experience as Mr. H. W. Page (*Med.-Chir. Trans.*, vol. lxxii. p. 379). Here the intestine attached to the stomach was the ileum, nine inches from its lower end. This patient lived for ten weeks, and though greatly relieved from vomiting and nausea, began to lose ground at the end of six weeks. Mr. Page quotes some other cases, a striking one being that of Lauenstein (*Cent. f. Chir.*, 1888, p. 472). Here the intestine opened was only fifteen inches from the ileo-cæcal valve. The patient began to have diarrhœa on the fourth day, passed unchanged food in her stools, and died on the eleventh day.

The selected loop of jejunum should be so arranged that its distal part may be nearest the pylorus, and lowest upon the stomach, so that drainage into the proper limb may be facilitated. The details of suturing are the same as already described.

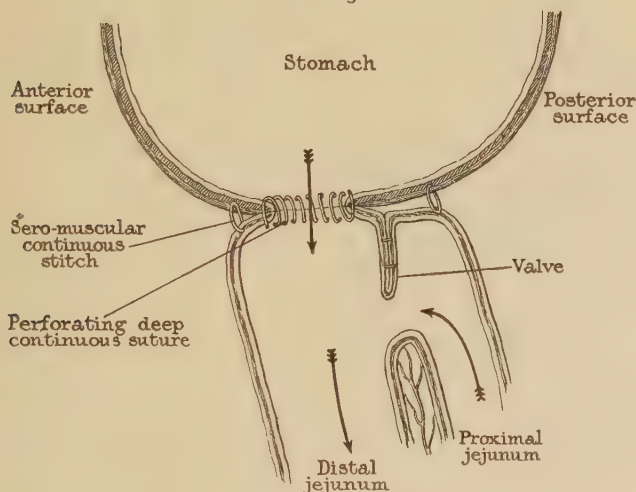
A few sutures may be inserted to fix the proximal limb of the jejunum to the stomach above and to the left of the anastomosis. It is important to make the opening low enough in the jejunum to allow easy approximation of the parts without tension, and without compression of the colon; but the danger of intestinal obstruction from this cause has been greatly exaggerated. On the other hand, the chosen spot

must not be low enough for the loop to produce a potential hernial aperture.

In some stout patients with bulky great omenta, the latter may have to be slit vertically to allow the proper part of the jejunum to be brought to the stomach without tension and without troublesome folding of the great omentum.

Kocher having noticed fatal cases occurring after successful suturing and without peritonitis, a fact only to be attributed to the absorption of intestinal contents which have reached and undergone decomposition in the stomach, unites the intestine not with the two long axes corresponding, but with the intestine at right angles to the length of the stomach and in such a way that the distal part of loop descends in front of the proximal limb. Still further to ensure that the contents of the

FIG. 203.



Kocher's antero-inferior gastro-jejunostomy with valve formation, to guard the opening of the proximal limb of the jejunal loop. (Modified from Kocher.)

stomach and those of the proximal part of the intestine should pass out into the distal portion without any regurgitation, Kocher makes a valve* (Fig. 203) by infolding the convex upper wall of the loop of intestine just behind the anastomotic opening. This transverse fold is maintained by means of a continuous sero-muscular suture; it is made before the loop is joined to the stomach. When the operation is completed, the proximal limb does not open into the stomach, but fluid can pass along the mesenteric border into the distal part of the intestine. With the same object Kocher makes the incisions into the stomach and jejunum crescentic with the convexity upwards; this also allows a larger opening to be made into the jejunum, which is incised transversely to its axis.

Prof. Kocher has had splendid success with this method, and out of 100 cases only three deaths occurred, and these "were not referable to

* Wölfler made a valve of the stomach wall to cover the orifice of the proximal limb of jejunum, but this was not very efficient.

the complications of the operation, but to the disease itself," and Dr. Kaiser's careful examinations of Kocher's cases proves that the late results are excellent. These results are doubtless due more to the great experience and skill of Prof. Kocher than the special method employed.

(D) **Posterior Gastro-jejunostomy with a Loop.**—The only essential difference between this and the posterior "no-loop" operation already described in detail is that the part of the reversed jejunum to be clamped and attached to the stomach is about eight inches below its origin at the duodeno-jejunal flexure.

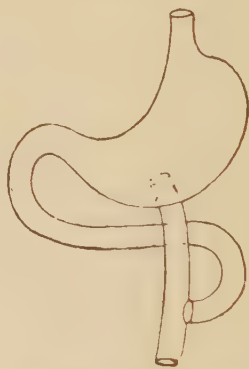
This makes the operation a little easier, for the selected part of the bowel can be more readily brought out of the wound and secured by the clamps. On the whole the results obtained with this operation, which has been extensively used, are fair, especially as regards the immediate

FIG. 204.



Gastro-jejunostomy by another method of Wölfler's. (Von Esmarch and Kowalzig.)

FIG. 205.



Posterior gastro-jejunostomy by Roux's Y method. (Mayo Robson and Moynihan.) The opening into the stomach should be close to the greater curvature.

results, but the presence of the short loop predisposes to obstruction by kinking or flattening at the gastric attachment.

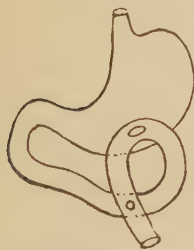
Therefore secondary operations have been unusually frequent after this method, even more frequent than after the anterior operation. Mayo records 53 cases, with 3 deaths, and 7 secondary operations, for bile regurgitation either in small quantities often repeated, or occasionally in large amounts. For this reason many surgeons have resorted to the no-loop operation, while others have performed entero-anastomosis at the same time in their endeavour to avoid the vicious circle.

(E) **Roux's Y Method.**—Wölfler first suggested this operation, which has been improved and popularised by Roux. The jejunum is cut across and the distal portion is joined to the stomach either posteriorly or anteriorly. The proximal end is implanted into the left side of the distal part. The stomach is clamped in the usual way, and the jejunum is divided between two intestinal clamps, holding the bowel and the mesentery. It is simpler to secure a loop of bowel and its mesentery with one long clamp. For the posterior operation the division should be about six inches from the duodeno-jejunal flexure.

For the anterior operation the jejunum may be conveniently divided about twelve inches from its origin. The mesenteric vessels are secured by transfixing and ligaturing the mesentery behind the clamps. The distal part of the bowel is then joined to the stomach by two rows of sutures as described at p. 506, and the proximal end to the left side of the distal part at least three inches below the stomach, otherwise bile and pancreatic juice may regurgitate into the stomach. An elliptical piece of gastric mucosa is excised in order to secure a patent fistula.

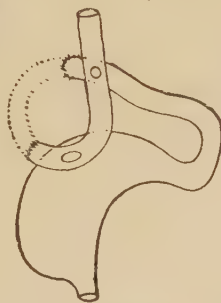
The advantages of the Y method.—(1) It is the surest method of preventing “vicious circle.” It is impossible for food to pass from the stomach into the proximal loop, and it is difficult for bile, pancreatic juice and intestinal contents to enter the stomach through the gastro-enterostomy. (2) It provides an excellent means of emptying the stomach without delay, and for this reason it is recommended by Kocher for all cases in which this is essential, especially in malignant or other cases with early decomposition of the gastric contents.

FIG. 206.



Posterior gastro-jejunostomy with entero-anastomosis after Braun and Jaboulay. (Mayo Robson and Moynihan.) Posterior view.

FIG. 207.



Doyen's operation. (Mayo Robson and Moynihan.) Two anastomosis and division with occlusion of the proximal limb.

The disadvantages are: (1) That the two anastomosis make the operation more complicated and prolonged, so that it is not suitable for grave cases, and routine use. (2) Now that “regurgitant” vomiting is known to be preventable by simpler means, and effectual drainage can be provided by making a large opening suitably placed, it is no longer necessary to use Roux's more tedious and serious method. (3) The danger of peptic jejunal ulcer is increased because a portion of the bowel is exposed to the action of the gastric juice, without the neutralising effects of the bile and pancreatic juice (Paterson). In malignant disease this objection does not hold, for jejunal ulcer has not yet been known to follow in carcinomatous cases (Moynihan, *Lancet*, 1906, vol. i. p. 1071).

(F) **Gastro-enterostomy with entero-anastomosis** (Braun, Jaboulay and Weir).—This, a simpler but less effectual method, which has been designed for the same purpose and has the same objections as Roux's method. Entero-anastomosis has often been resorted to for vomiting coming on either early or late after loop operations, and it has generally but not always proved successful. The anastomosis is made between the limbs of the loop about three inches below the gastric attachment. The details of technique have been already described at p. 404.

Gastro-jejunostomy and entero-anastomosis with occlusion of the proximal limb of the loop, either with the silver wire ligature of Fowler (*Ann. of Surg.*, vol. xxxvi. p. 695), or the Scott-Mattoli suture is not to be recommended, for all these complicated and tedious procedures are unnecessary and they have nearly all the objections of loop operations with entero-anastomosis. Further, ligation or plication may not be effectual in preventing the chyme from entering the afferent limb, or may even cause troublesome adhesions necessitating operative treatment as in one of Mayo's cases.

To attempt to partially occlude the proximal limb without effecting entero-anastomosis lower down is simply to court disaster. If the pylorus is patent enough to allow any food to pass on into the duodenum, the afferent limb then becomes greatly distended from true intestinal obstruction, which can only be relieved by a secondary entero-anastomosis, which may have to be performed under unfavourable circumstances.

Doyen's method of division and occlusion of the proximal limb was followed by invagination of the occluded part through the lateral anastomosis in one case recorded by Mayo. It is too complicated for general use (Fig. 207).

(G) **Gastro-jejunostomy by Murphy's Button.**—This is one of the simplest of all the methods of gastro-jejunostomy; it is also the least satisfactory (*vide* p. 501) at the present day. As has been the case with this most ingenious instrument after resection of the intestine, it has scored many brilliant successes, but in both cases there is reason to believe that the extreme simplicity of the method has led to its use in many cases which have not been published because unsuccessful. Dr. Murphy in 1895 (*Lancet*, vol. i. p. 104) spoke of there having been twenty-seven cases with nine deaths. Published results during recent years have, however, been far superior to this; for instance, Czerny has made use of this method more than a hundred times, without a death attributable to the button, *vide* also the results given on p. 519. Out of 69 consecutive cases collected by Dr. Ticehurst from the records of a large general hospital in a poor district, 23 died, three from leakage into the peritonæum from want of proper union, and in one of these a perforation had also occurred near the button. In four of the fatal cases in Dr. Murphy's list, death occurred from exhaustion before the fourth day, and it is stated that in each the approximation was perfect. This date is too early to speak with confidence of the approximation brought about by the button. After remaining perfect for a longer time it may suddenly fail, as in the following case of my own:—

A patient of Dr. Pye-Smith's, at Guy's Hospital, aged 45, was transferred to my care in April 1895, with carcinoma of the pylorus. When the stomach was exposed the growth was too extensive to admit of pylorotomy. It extended for an inch and a half into the pyloric end of the stomach, and sent numerous vascular processes along the lymphatics into both omenta. I united a loop high up in the jejunum to the anterior wall of the stomach, a little to the cardiac side of the centre of the anterior wall so as to be free of the growth. The only difficulty in the operation was making certain of the jejunum. Every step of the union of the viscera was rendered most easy by the button. For seven days the course was uneventful save for obstinate, fixed, gnawing pain which I attributed to the button having to make its way through a thick-walled viscus well supplied with nerves. On the seventh day the bowels acted

after an enema. On the eighth this action was repeated, and a small slough was found in the stool. Shortly after, symptoms pointing to perforation occurred, with rapid collapse and death. It is greatly to be regretted that, as the man was one of the paying hospital patients, no necropsy was made.

I have already (p. 370) spoken fully of what I consider to be the dangers of the Murphy button. It is fair to this method to say that the carcinoma was here extensive, vascular, and growing rapidly in a comparatively young patient. It is possible, therefore, that in spite of my precaution I may have placed it in tissues already affected by growth and thus certain to soften prematurely. I did not make use of the v. Hacker position, as preferred by Dr. Murphy, because the anterior or Wölfler method has given very good results, and because, owing to the extension of the growth into the omenta, I was unwilling to disturb the parts more than was absolutely needful. The button should be passed by the fourteenth or twenty-first day. M. Quénu gives the following result of a gastro-enterostomy performed by means of a button. A year after the operation the patient (who had greatly improved) began to fail, and died sixteen months after the operation, jaundiced and emaciated, but without vomiting. The button was found in the stomach, having caused no symptoms. The communication between the viscera was freely open. Recurrence of the carcinoma had involved the pancreatic and bile ducts.

The button has the following disadvantages: The brothers Mayo (*Ann. of Surg.*, 1905, vol. xlii. p. 646) in 57 cases had four deaths from separation at the line of union between the sixth and tenth day. Since then they have reinforced the anastomosis by mattress sutures. This leakage after some days has been a common experience. The opening cannot be made large enough for efficient drainage, and the orifice has been shown to contract more frequently than after other methods. Paterson in his lectures mentions three cases in which the fistula had completely closed after intervals of three and five months respectively, and two closures occurred in 69 Guy's Hospital cases. The button may act as a foreign body either in the stomach or in the intestine. Mayo mentions two cases in which it had to be removed from the stomach. Dr. Hawkins and Mr. Nitch (*loc. supra cit.*) record another case in which the button caused intestinal obstruction which fortunately did not end fatally, the button being successfully removed by operation.

As Dr. Ticehurst points out, the button may pass the right way, or it may enter the stomach or the proximal loop, or it may reach the duodenum. In nine cases of his collection it was known to have been retained in the stomach, and in not one of these did the operation give any permanent relief.

Hildebrand and Weir have modified the button with the object of preventing its entrance and retention in the stomach as far as possible, but no modification will certainly prevent the button falling into the stomach in anterior operations.

Dr. Murphy (*loc. supra cit.*) gives the following conclusion: (1) That gastro-jejunostomy should never be performed on an extremely cachectic patient. (2) The von Hacker position (p. 192) is preferable, though that of Wölfler may be used. The former favours the passage of the button into the intestine. Out of the cases in which the approximation has been made to the anterior wall of the stomach, the button has

dropped back into this viscus in four; in none of them did it give any unpleasant results, and Dr. Murphy believes that it would have passed as soon as the stomach had contracted in size and the patient was up and about. (3) Owing to the poor reparative power of the tissues in these patients, it is well to scarify with a needle the adjacent peritonæal surfaces of stomach and intestine: this hastens the formation of adhesions. (4) A few interrupted supporting sutures between the stomach and intestine, half an inch from the button, may be necessary where there is any tension on the parts. (5) The patient should receive liquid nourishment as soon as the effects of the anæsthetic pass away.

The earlier steps of the operation are as already described. In placing the button in the stomach and jejunum it is advisable, as recommended by Carle and Fontino (*Arch. f. klin. Chir.*, Bd. lvi. Heft 1), to dispense with the purse-string suture, substituting one or two simple sutures at each side of the button after the latter has been forced into the stomach or intestine through as small an incision as possible. This prevents the puckering produced by the purse-string suture, and ensures uniform contact between broad serous surfaces. Kammerer (*Ann. of Surg.*, July 1900, p. 30) adopted this plan in eleven successful cases of posterior gastro-jejuno-stomy, and speaks strongly in favour of the method.

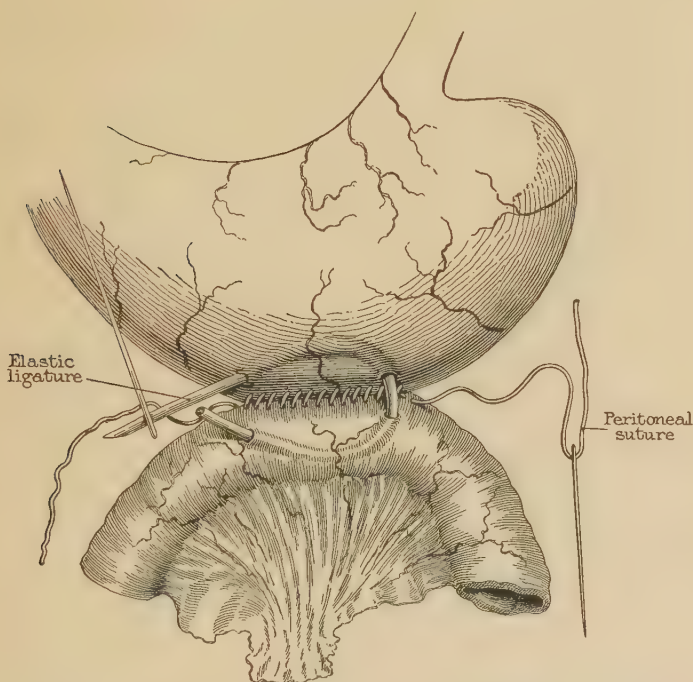
(H) **Gastro-jejuno-stomy by means of Decalcified Bone Bobbins.**—This method has been recommended by Mr. Mayo Robson (*Med.-Chir. Trans.*, vol. lxxv. p. 419, and *Brit. Med. Journ.*, vol. i. 1900, p. 628) (*vide* pp. 373 to 376). It is claimed (*Diseases of the Stomach*, Robson and Moynihan, 1904) that this method prevents narrowing of the orifice by tight sutures; that the bobbin acts as a splint to and protects the line of suture; that an immediate opening is ensured; that the button soon dissolves, leaving no foreign body in the intestine; and that the method is rapid, easy, efficient and safe. These advantages are obtained by using clamp forceps, which allow the opening to be made of any desirable size, independently of the size of bobbin available. For these reasons, we greatly prefer to dispense with bone bobbins, and employ the clamps of Doyen or Carwardine. The bobbin has, however, given very good results in the able hands of its originator, who still recommends it (*Med. Ann.*, 1906, p. 486).

In 103 cases of posterior gastro-jejuno-stomy performed with the aid of the bobbin, Mr. Robson states that there were only four deaths, and that the anastomosis was not at fault in any of these (*Med. Ann.*, 1904).

Operation.—The chosen portions of the stomach and intestine are drawn well up into the wound, emptied, and held in position by forceps which act as guides to the spots to be opened. The peritonæal sac having been thoroughly shut off with sterile gauze, two continuous sutures, one sero-serous and securing peritonæal apposition for fully one-third of an inch from the opening all round; the other, marginal and muco-mucous, when drawn tight, firmly applies the edges of the openings in the stomach and jejunum to the tube, thus preventing any extravasation. The sero-serous, on a curved needle, is first inserted, half or one-third of an inch from the spot where the viscera are to be opened, first to jejunum and stomach alternately, the suture taking up peritonæum and outer muscular coat only. This suture is left long at

the end where it begins, and when the extreme opposite end is reached it is not unthreaded, in order to complete the suturing after the bobbin has been inserted, and the marginal or muco-mucous suture completed. The viscera are then opened, the openings being just sufficient to admit the bobbin, but before its insertion the marginal suture, which should be of chromicised gut, is applied from right to left, uniting the posterior margins of the two visceral openings, the suture including mucous membrane, and being left long on the right and kept threaded on the left. The bobbin is next inserted, and the marginal suture then proceeded with round the front until the tail of the suture is reached: the

FIG. 208.



Dr. McGraw's elastic ligature method of gastro-jejunosomy. (Modified from Dr. H. O. Walker, *Journ. Amer. Med. Assoc.*, Jan. 17, 1903.) The posterior sero-muscular suture has been placed. The elastic ligature is rather too near the mesentery of the intestine, and a little too high on the stomach.

two ends are then tightened, tied and cut short, thus uniting the mucous surfaces round the tube. The serous suture is then proceeded with half or a third of an inch from the marginal one until the circuit is completed, when the two ends are tightened, tied and cut short. When the anastomosis is complete, the sutures cannot be seen (M. Robson).

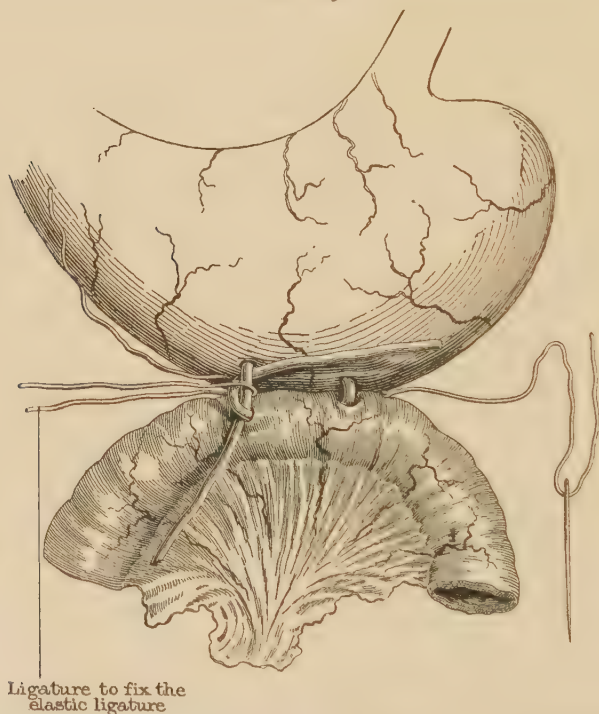
The Elastic Ligature Method (McGraw).—This method has been discussed, and the mode of its application has been already described under intestinal anastomosis, p. 406 (*vide* Figs. 208 to 210).

Its use for gastro-jejunosomy is very similar, and it can be employed for performing either the anterior, or the posterior operation with or

without a loop. The opening should be made large enough, at least two and a half inches long. The accompanying figures illustrate its use. Care must be taken to include all the mucous membrane of the stomach and jejunum within the bite of the ligature, and not to pierce any of the prominent folds of the mucosa, which may otherwise remain as bridges across the fistula (McGraw, *Med. News.*, Oct. 24, 1903).

Although this method is undoubtedly simple, easy, very rapid, and accompanied with less risk of shock and sepsis than most other methods, it has the serious disadvantage of not providing an immediate opening, so that mouth feeding may have to be delayed for about four days in

FIG. 209.



Dr. McGraw's elastic ligature method of gastro-jejunostomy. (Modified from Dr. Walker.) The tying of the ligature.

cases of pyloric obstruction, for which it is therefore absolutely contra-indicated. The subjects of pyloric obstruction are not in a condition to stand the starvation, and much of the success of the present day is due to early feeding in these cases. Rectal feeding is a very poor substitute, especially in marasmic patients. I prefer to make the anastomosis with the aid of clamp forceps and continuous sutures, for the reasons already given.

Dr. W. J. Mayo (*Ann. of Surg.*, 1905, vol. xlii., p. 646) records 36 gastro-jejunostomies by means of the elastic ligature, 17 for benign disease with 2 deaths (7 per cent.), 19 for malignant disease with 3 deaths (15 per cent.). Dr. Mayo states that the orifice is likely to contract especially if the pylorus be patent, but recent experiments by

Dr. Dudley Tait and various Continental observers tend to show that if the ligature be properly applied, there is no unusual risk of narrowing of the stoma. It is of course true that with an open pylorus all gastro-jejunosomy openings tend to close in time unless they are made of very large size.

After-treatment.—It is certain that surgeons have been over-anxious with regard to commencing to feed their patients after this operation. After careful suturing, or indeed after any of the methods of gastro-jejunosomy, feeding by the mouth should be carefully begun within a few hours of the operation. Such liquids as peptones, Valentine's

FIG. 210.



Dr. McGraw's elastic ligature method of gastro-jejunosomy. (Modified from Dr. Walker.) The operation completed. The sero-muscular suture shows too much. A Cushing's suture is better, for it buries itself, and is followed by few adhesions.

meat juice, raw meat juice, champagne, veal tea, brandy and water, may be given in teaspoonfuls every half-hour at first and soon increased up to half-ounces every hour. Iced whipped egg and iced milk may be given (Lenhartz), and this has the advantage of providing proteid for combination with free hydrochloric acid and of preventing its digestive action upon the newly joined and inflamed tissues. Jelly may also be soon given. When the operation has been performed for hæmorrhage more delay and caution are required.

Shock may be treated by warmth, and by the subcutaneous injection of adrenalin chloride (20 m. of the $\frac{1}{1000}$ solution every hour), aseptic ergot or ernutin. Collapse may be combated by warmth, rectal saline injections, subcutaneous saline infusions, either repeated or continuous.

In graver cases intravenous injection of 6 per cent. solution of dextrose may be used with advantage (Beddard).

As soon as possible the patient should be placed in the semi-sitting posture, in order to prevent pulmonary complications as far as possible, and also to lessen the risk of vomiting. If severe vomiting occur, rectal feeding must be adopted, and continued if it does not increase the vomiting, as it may do occasionally. Gastric lavage with a soft tube may be resorted to in grave cases during the first or second day, while there is but little risk of doing any harm to the sutured tissues. If the vomiting persist entero-anastomosis, if practicable, ought to be adopted without too much delay.

Complications and Sequelæ of Gastro-jejunostomy.

(A) In the cases which recover—

(i.) In most benign cases great relief is given permanently. Paterson estimates that 90 per cent. of these patients remain cured, but I think that these figures are optimistic.

(ii.) In many malignant cases, great relief is given for a varying number of months from pain, vomiting, dyspepsia, &c., while a gain of flesh is often made and maintained for months.

(iii.) In many others the relief is much more short-lived; the patient after a short period of relief, though the appetite is voracious, makes no flesh, and quickly goes down hill again.

(iv.) In a few cases both innocent and malignant. Acute and serious vomiting occurs from kinking, spur formation, folds of mucous membrane obstructing the efferent limb of the jejunal loop, or water-logging of the obstructed proximal limb, which then causes closure of the efferent opening.

(v.) In a few cases chronic and annoying or even serious vomiting gradually develops from the same causes or from contraction of the orifice or retention of a Murphy button.

(vi.) In rare cases intestinal obstruction occurs from undue pressure on the colon, jejunum or duodenum, or from the development of an internal hernia.

(vii.) Occasionally a peptic jejunal ulcer may perforate.

Most of these sequelæ have become much more rare of late, and they should almost cease to occur with greater perfection of technique.

(B) In fatal cases the causes of death have been sufficiently indicated in the preceding pages, viz., shock, collapse from previous exhaustion and want of fluids; pulmonary complications, which are especially apt to follow all operations upon the stomach; persistent vomiting; peritonitis, whether due to sepsis introduced at the time of the operation or to leakage later on, brought about by some fault in the technique of direct suture, by the use of the button, or by rough handling and perforation of a gastric or duodenal ulcer; and recurrent hæmorrhage from some of the vessels not being secured by the sutures (or by ligature), or from a disturbed gastric or duodenal ulcer.

GASTROPLICATION.

This operation, which was first performed by Bircher in 1891, has for its object the reduction of the size of a dilated stomach. This is accomplished by making one or more longitudinal folds or tucks in the

wall of the stomach by means of sutures. The operation has been performed a number of times. Mayo Robson (*Lancet*, March 24, 1900, p. 831) gives a list of 28 cases, with two deaths. In one of the fatal cases, however, death was due to syncope two weeks after operation, so cannot be ascribed to the operation.

Some of these operations were performed in cases in which definite pyloric stenosis was the cause of the dilated stomach. It is clear that such a proceeding cannot be of any value unless the pyloric stenosis is relieved at the same time by pyloroplasty or gastro-jejunostomy, and even then the propriety of gastroplication is doubtful, since there is a good deal of evidence to show that a dilated stomach contracts very considerably after removal of the cause of dilatation.

The application of gastroplication therefore should be limited to those very rare cases of idiopathic dilatation of the stomach. Even in these cases the question of gastro-jejunostomy should be considered, for, as Farquhar Curtis (*Ann. of Surg.*, July, 1900, p. 49) says, "If the surgeon should chance to overlook some cause of pyloric obstruction his patient will be sure of a cure if he survives the operation, whereas gastroplication will be useless if pyloric obstruction exists."

Some years ago I remember seeing gastroplication being performed upon a middle-aged man, who was suffering from gastric-dilatation, which was probably due to seasickness and excessive eating. Considerable relief was given for about six months. Later anterior gastro-jejunostomy was performed, and this again gave temporary relief. Subsequently posterior gastro-jejunostomy was resorted to, and made the patient much more comfortable, at least, for a time. When I last heard of him he remained fairly well. During the anterior gastro-jejunostomy it was noticed that the stomach was as large as ever.

Operations for the Relief of Gastropptosis—Gastropexy.—Gastropptosis rarely occurs alone, but generally forms a part of Glenard's disease or enteropptosis, in which most of the abdominal viscera are unduly movable, and the parietes wasted and flabby.

The subjects of this disease are usually women of a neurasthenic temperament, and they rarely derive much benefit from surgical interference of any kind. Suitable abdominal belts are usually sufficient, but they are not always satisfactory.

A certain amount of prolapse of the stomach also develops in cases of severe dilatation. The prolapsed stomach may become more or less obstructed from kinking at the pylorus; but dilatation is more often atonic and due to malnutrition.

Duret in 1896 (*Revue de Chir.*, 1896, p. 430) sutured the stomach to the anterior abdominal wall above the umbilicus; the patient was greatly relieved and gained flesh. Rosving and Davies have used analogous measures.

The chief objection to this procedure is that it may fix the stomach unduly and interfere with its proper peristalsis in the same way that adhesions from other causes do; but the gravity of adhesions has been greatly exaggerated.

H. D. Beyea (*Phil. Med. Journ.*, 1903, p. 257) shortens the gastro-hepatic and gastro-phrenic ligaments by plicating them to the required degree by means of three rows of interrupted silk sutures, each suture when tied making a transverse fold.

Bier shortens the small omentum in the same way, and he also fixes the pylorus to the capsule of the liver. Beyea and Bier have operated

upon four cases each, with relief of symptoms and improvement of the general health.

Coffey (*Phil. Med. Journ.*, Oct. 11, 1902) sutures the gastro-colic omentum about one inch below the greater curvature, the parietal peritonæum about one inch above the umbilicus; and in bad cases he advises fixation of the great omentum below the pendulous colon to the parietal peritonæum. He records two cases with great improvement.

The advantage of the method of Beyea is that the gastric peristalsis will not be interfered with, and the same is probably true of Coffey's operation.

Until more cases are recorded and followed up it is impossible to arrive at a definite conclusion concerning the value or otherwise of these procedures.

DUODENOSTOMY.

This and the following operation have been proposed, in cases unsuited for pylorotomy, as a means of getting nourishment into the alimentary canal below the disease, and thus giving rest to the diseased parts, especially in those cases of infiltration of the whole of the stomach, rendering gastro-jejunostomy impracticable. But little favour has been accorded to either of these operations, and both are destined to be rarely required. Duodenostomy especially has the serious objections that it deals with a fixed portion of intestine, one difficult to deal with, and one into which important fluids are poured, which thus may readily escape from a fistula made here. After mobilising the duodenum after Kocker's method, the operation would be more practicable, but for the cases in which an opening is needed, the pylorus is usually diseased and fixed so that a jejunostomy is more suitable. Furthermore, all the cases have, I believe, been fatal.

JEJUNOSTOMY.

This operation has the serious disadvantage of being liable to leakage at a point high up in the alimentary canal, where the fluids traversing the bowel are of the greatest importance from a nutritive point of view. Thus it has followed in the majority of cases that no great prolongation of life has resulted from this operation. Dr. Hahn (*Deut. Med. Woch.*, 1894) gives a list of five cases of jejunostomy. One, a case of gastric carcinoma, died in a fortnight; another, a case of œsophageal carcinoma, died in four days; the third, a girl aged 23, who five weeks before had drunk sulphuric acid, died on the eighth day. Mr. Jessett (*Dis. of the Stomach and Intestines*, p. 64) relates two cases operated on for œsophageal carcinoma. One survived nine months, when extension of the disease proved fatal. The other only survived seven weeks. Mr. Golding Bird brought a case before the Clinical Society (*Trans.*, vol. xix. p. 70); here the operation was performed for advanced carcinoma of the pylorus. The patient was making a good recovery up to the ninth day, when fatal peritonitis occurred owing to an accident in the feeding. Recent improvements in the operation may prove of value in preventing leakage and diminishing the mortality.

Indications.—(1) Cases of carcinoma of the pylorus and stomach

where other operations are impossible. (2) Cases of carcinoma of the cardiac end of the stomach and œsophagus when gastrostomy is out of the question. (3) Cases of simple general cicatricial contraction of the stomach, the effect of caustic liquids. It has been suggested also as a means of treating gastric hæmorrhage, but this suggestion is to be condemned.

Operations.—Three methods will be briefly described: (1) Maydl's method; (2) Moynihan's adaptation of Witzel method of gastrostomy; (3) Gibson's adaptation of Kader's method of gastrostomy.

The abdomen is opened through the upper part of the left rectus and the duodeno jejunal flexure is sought, and found in the manner already described (p. 508). It is then traced down for about eight inches, and a loop is brought out of the abdomen. So far all the operations are alike.

(1) *Maydl's Method.*—The loop is emptied and clamped across at its base, the clamp securing both limbs of the loop and the mesentery. The intestine is cut across and the mesentery is tied and incised to the required degree. The proximal open end is implanted into the side of distal part at least three inches down, the remaining at end is fixed in the parietal wound. The peristalsis in the part of the bowel which is joined to the wound is away from the fistulous opening. This operation resembles Roux's method of gastro-jejuno-stomy (p. 516) (*Brit. Med. Journ.*, June, 1902; *Abdominal Operations*, 1906, p. 243).

(2) *Moynihan's Adaptation of Witzel Method of Gastrostomy.*—A small opening is made into the intestine near the distal extremity of the exposed loop, and on the side opposite to the mesentery a rubber tube about the size of a No. 12 catheter is inserted "and fixed by a single catgut stitch, which includes the cut edge of the bowel and the side of the tube." The tube is laid upon the ante-mesenteric border (towards the origin of the jejunum), and buried by means of a continuous suture (*vide* Figs. 164, 165). The tube should be buried for about two inches, and the suture should extend well below the opening into the intestine. The intestine is fixed to the parietal peritonæum, and the wound closed around the tube, which is left long. A funnel may be inserted in the end of the tube for feeding purposes. At first only about six to ten ounces are given. Mr. Golding-Bird found that a meal of fifteen or twenty ounces every four hours caused symptoms of over-distension. Moynihan states that "after the first few days up to a pint may be given in the space of ten minutes."

(3) *Gibson's Adaptation of Kader's Method of Gastrostomy* (*Bost. Med. and Surg. Journ.*, Sept, 25, 1902).—This is not nearly so suitable as the method just described, for the shape and size of the small intestine does not favour the adoption of Kader's method with a sufficient guarantee against leakage, without also causing undue narrowing of the intestine and interference with the flow of fluid from the intestine above.

CHAPTER VIII.

EXCISION OF THE SPLEEN: SPLENOPEXY.

Indications.—All of these are rare, and many of them are still doubtful.

1. *Cystic Spleen.*—When this is found to be unsuited for incision and drainage. Mr. K. Thornton's case of this kind was the first successful splenectomy in England. In some cases extensive adhesions make splenectomy impossible.

2. *Injury.*—This has been already alluded to when gunshot injuries of the abdomen were considered (p. 433). Other cases in which it may be called for are, prolapse of a spleen, injured or not, through a wound, rupture of the spleen, and stabs of this viscus. Hitherto surgeons have often been deterred from attempting to remove a ruptured spleen by the frequency with which this injury is complicated by injury to other abdominal or thoracic organs, especially the liver itself. From the shock of these the patient never rallies sufficiently to justify exploration. Fresh interest will be called to this matter by three successful cases of splenectomy for rupture of the spleen brought by Messrs. Ballance and Pitts before the Clinical Society (*Lancet*, vol. i. 1896, p. 484).

In the first case, under Mr. Ballance, a boy, aged 10, had been struck five days before his admission into St. Thomas's Hospital by a "full-pitched ball" on the left side. Severe pain followed, but passed off until a few hours before admission. At this time severe shock was present from which the patient rallied slightly. The spleen was removed through a four-inch incision in the left linea semilunaris.* It was noticed that a speniculus was left behind. The boy recovered rapidly, and was in robust health five months later, but the superficial glands had enlarged.

In the second case, also under Mr. Ballance, the patient, a woman, aged 45, had been run over by a hansom cab. Shock was so marked a feature that operation was not justified until the next day. Though the patient left the theatre in a desperate condition, in ten days she was apparently convalescent. Then she began to go downhill, and by the eighteenth day her condition was again critical, with weakness, emaciation, thirst, drowsiness, &c. The administration of extract of sheep's spleen and raw bone marrow daily restored her gradually to convalescence and ultimately to complete recovery. Some groups of external lymphatic glands could be felt in this case.

In the third case, under the care of Mr. Pitts, a man, aged 36, had fallen on an iron girder, striking his left side. He complained of pain there, but was otherwise apparently well. About four hours later he became suddenly collapsed. Four hours afterwards he had responded sufficiently to restoratives to make operation justifiable. This patient, when apparently convalescent, began to lose ground in a similar way

* In one at least of these three cases the spleen appears to have been removed by a median incision. This would have the advantage of allowing the operator to investigate the state of the liver and kidneys.

to the second patient. Cod-liver oil and bone marrow were given, but it was not till arsenic was administered that any real improvement was observed. He ultimately gained robust health, but all the superficial lymphatic glands could be felt enlarged.

In each of these cases the spleen was not only ruptured, in the third completely across, but the vessels in the hilum were torn across also. The authors remarked that where this was not present a rupture of moderate severity might perhaps be treated by suture. As to the diagnosis of ruptured spleen these brilliant successes point to the value of the following: (a) The locality of the injury; (b) the evidence of internal hæmorrhage; (c) the great increase of fixed splenic dulness; (d) the evidence of an increasing collection of fluid in the abdomen, and of the fact that while the dulness in the right flank can be made to disappear by change of position, that in the left flank remains constant. The operation should be performed as soon as the diagnosis is made, for to wait for reaction from collapse is to wait for more hæmorrhage, and to throw away whatever chance the patient may have of recovery from early operation. If the operation be too long delayed infection of the clots will occur (Dudgeon). In the case of the spleen where an escape of blood alone follows on the rupture, the last mentioned most grave condition will not follow so quickly as in the case of the kidney. The peritonæal sac should be cleansed as thoroughly as possible from all blood and clots. Every precaution for meeting shock should be taken before and after the operation. Care must be taken not to delay the operation too long. In a recent case at Guy's Hospital one of us (R. P. R.) operated too late to save the man, who was blanched and collapsed from hæmorrhage.

A packing case had fallen upon the patient's right shoulder, twenty-five hours before the operation; pain in the left side and collapse came on rapidly, but these passed off so that an operation was not considered necessary at first. About an hour before the operation the man became rapidly worse, and developed all the signs of internal hæmorrhage and dulness in the splenic region. An incision was made through the left rectus and the spleen was removed without much difficulty, the pedicle having been secured as soon as possible with intestinal clamp-forceps. Continuous subcutaneous infusion of saline solution was adopted after the operation, but death occurred eighteen hours afterwards.

3. In rare cases of suppuration involving the spleen, but incision and drainage are more commonly called for, and are less dangerous.

4. *Movable or Wandering Spleen*.—When this condition causes troubles, analogous to those of movable kidney, not relieved by a belt or splenopexy.

Dr. McGraw (*Med. Rec.*, vol. xxxiii. No. 26) removed an enlarged and dislocated spleen, which formed a tumour in the right iliac fossa, and partially displaced the uterus and bladder. A week later pain in the left shoulder and left-sided pleuropneumonia supervened. Nine months afterwards the ligature was coughed up. Recovery followed.

The prolapsed spleen is often enlarged, and its pedicle may get twisted. Twisting of the pedicle and dislocation may lead to symptoms of chronic or acute intestinal obstruction, from interference with the colon. I have operated upon one case in which a diagnosis of intussusception had been made, the twisted and prolapsed organ having been mistaken for the tumour of that disease. The spleen was untwisted and

replaced, and the child recovered. No sutures were used to fix the spleen, on account of its congested state, and the grave condition of the infant.

Operation is far more satisfactory here than in most other morbid conditions of the spleen, as shown by the statistics of the last decade which are given by Collins Warren (*Ann. of Surg.*, 1901, vol. i. p. 521). During this period 43 cases of extirpation of wandering spleen have been recorded with only three deaths.

5. *Malignant Disease*.—Primary sarcomatous disease of the spleen is extremely rare. Up to the year 1890, five cases of splenectomy for sarcoma were reported by Hagen, of which three recovered and two died. From 1891—1900 Warren reports five further cases, including one of his own, of which four recovered and one died. Jepson and Albert (*Ann. of Surg.*, 1904, vol. xl. p. 80) have collected 32 cases, with 11 splenectomies and one enucleation. Three of the 11 patients died from the operation, and three of recurrence. Two have survived for more than four years.

6. *Splenic Anæmia*.—This condition must be carefully distinguished from splenic leukæmia. The latter is associated with marked leucocytosis, which is not the case in splenic anæmia. The chief symptoms are splenic hypertrophy, gradually increasing anæmia, of the secondary type (leucopænia), and a tendency to hæmorrhages. Collins Warren describes a case in which the disease was cured after removal of the spleen, and also mentions seven cases reported by Sippy, five of which recovered after splenectomy. Levison (*Ann. of Surg.*, vol. xxxviii. p. 670) records a successful case, and refers to another by Harris; also to 16 recorded by Maragliano and Terille with three deaths, two from hæmorrhage, but the diagnosis was not certain in either of these. Abortion followed the operation in one case, and curetting proved fatal.

7. *Malarial Spleen*.—With regard to the question of operation for this condition Collins Warren says: "Quite a number of malarial spleens have been removed in recent years, and the mortality per cent. of the operation is still diminishing. Hagen has collected 88 cases of malarial hypertrophy of the spleen, exclusive of wandering spleen. Of these cases, 24 previous to the year 1890 gave a mortality of 62.5 per cent., while 64 cases operated after the year 1890 gave a mortality of 23.4 per cent. When we consider the very large size that the organ often attains in this disease, and the unfavourable constitutional condition of the patient, such results, if not all that we could hope for are at least encouraging."

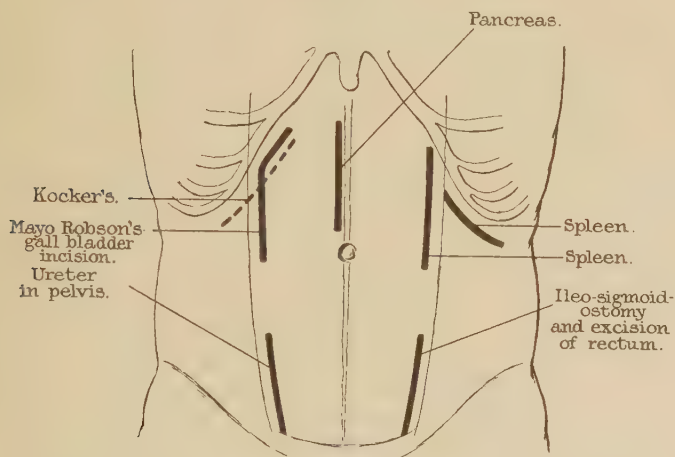
8. *Leukæmia*.—This operation has been so invariably fatal that it ought to be abandoned.*

Operation.—The preliminary steps will be directed to ensure asepsis and to diminish shock. The incision has usually been one in the linea alba. The advantages of this in the case of ruptured spleen have been given above. For other cases, that near the linea semilunaris, or one parallel to and about one and a half inches below the left costal margin (vide Fig. 211) would probably give better command over the pedicle. In any case the incision must be made free enough to give easy

* The late Mr. Greig Smith gave 18 cases; Mr. Thornton, 13; Mr. Collier, 16—all fatal. The only case which has recovered—Franzolini's of Turin (*Wien. Med. Woch.*, 1883, No. 20)—is considered one of hypertrophy by Thornton, Collier, and Crédé.

access to the pedicle without the need of traction upon the latter. Additional room may be gained by division of the left rectus. All hæmorrhage having been stopped, the peritonæum is opened freely and the hand explores the tumour. If at this stage the surgeon is satisfied that the adhesions between the spleen and the diaphragm are extensive and intimate he will do well to close his wound. If, however, it is decided to proceed, any adhesions, as of the overlying omentum, are separated, between ligatures if needful. Where the adhesions are very broad, interlocking chain-ligatures must be employed. In a very few cases the use of the thermo-cautery may be justified. Any adhesions with the pancreas are very difficult to deal with. Esmarch and Kowalzig advise removal of a portion of this viscus. The spleen is next brought out of the wound, the lower extremity first, and sterile gauze is carefully packed around it. This extraction of the viscus must be

FIG. 211.



Incisions for exposing the spleen.

The incisions for various other operations are shown.

carried on with the utmost caution and gentleness, as its friability may easily lead to a tear and most profuse oozing, and as dragging on the pedicle may easily induce collapse, and is also likely to lead to some small vessel retracting from the ligatures as they are applied, and causing fatal hæmorrhage.

The spleen being wholly outside the body, the most important part of the operation, securing the pedicle, remains. The lieno-renal ligament and the gastro-splenic omentum have to be tied. Collins Warren finds that the remainder of the operation is greatly facilitated if the spleen is at this stage rotated forwards so that the posterior surface of the organ is in front. A better view of the pedicle is thus obtained without stretching, and the application of ligatures is therefore rendered easier. The pedicle, if present,* must now be carefully examined. If the

* In case of Mr. L. Browne's (*Lancet*, vol. ii, 1877, p. 310) there was no pedicle as such, four very large arteries being met with and secured with double ligatures.

patient's condition is good, the safest plan will be to secure the vessels as far as possible separately, the pedicle being divided as the late Mr. Greig Smith suggested, piecemeal between pressure-forceps; where there is not time for this, it will be wiser to secure the vessels in two or three portions, transfixing in two places, and interlocking the ligatures (Thornton). Long clamp-forceps may be found very useful to secure and hold the whole pedicle as suggested by Mr. Moynihan. I have used intestinal clamps in one case to arrest profuse bleeding from the severely lacerated spleen. The wide pedicle was then transfixed and ligatured between the clamp and the stomach. Sterilised silk should be used, fairly stout, and not tied so tightly that it will cut its way through too quickly. However the pedicle is treated, the following precautions should be followed: (1) To prevent any tension being exerted on the pedicle (*vide supra*). (2) To secure every vessel. (3) To divide these, in a relaxed condition, at a sufficient distance from the ligatures. (4) Not to include the tail of the pancreas. (5) After all the ligatures have been applied, it may be well for sake of safety to throw one round the whole. (6) Not to twist the spleen round at all in dealing with the pedicle.* When oozing from adhesions is very likely to take place, especially when a large gap is left by the removal of a huge spleen, plugging with iodoform gauze after the method of Mikulicz will be advisable (p. 339).

The abdominal sac is next cleansed and the parietal wound completely closed except in septic cases or those requiring temporary gauze packing for troublesome oozing.

Causes of Death.—By far the most frequent is hæmorrhage. This may be from the omentum adherent over the spleen, from the large vessels to this viscus, from some small vessel which has retracted, from the splenic vein, or from sponge-like adhesions (Bryant).

Mr. Hatch, of Bombay (*Lancet*, 1889, vol. ii. p. 1053), met with a case in which death took place a few hours after the splenectomy, owing to oozing from some adhesions between the spleen and the diaphragm, which had required separation.† The pedicle was safely secured. In another case (*Centr. f. Chir.*, July 18, 1885), death, twenty-four hours after the operation, was due to bleeding from the abdominal incision, owing to the defective coagulation of leukæmic blood. The ligature on the pedicle was firm.

The after-treatment of post-operative anæmia, &c., is given at p. 527.

Splenopexy or Fixation of a Wandering Spleen.—This is an operation which is rarely required, for undue mobility of the spleen is usually only a part of Glenard's disease, when it can be best treated by means of abdominal supports. In other cases the mobility is due to an increase of size, due to organic disease, which may or may not require operative treatment. In some cases, however, a wandering spleen may cause pain, sickness, and faintness, and may prevent the patient from leading an active life. When a good belt has been well tried and has failed to afford relief, an operation may be suggested.

* Sir S. Wells (*Med. Times and Gaz.*, Jan. 6, 1866, p. 4) draws attention to this. Having done so in order to bring the vessels into a cord, the splenic vein was ruptured.

† See also G. A. Wright's case (*Med. Chron.*, Dec. 1888). This surgeon suggests the use of a long, sharply-curved tenaculum for stopping bleeding from a deeply-seated vessel in the back of the abdomen.

In suitable cases without any disease of the spleen, but only undue mobility, splenopexy should be preferred to splenectomy, and it ought to be more free of immediate danger and of possible changes in nutrition (p. 527).

Operation has only been adopted in a few cases so far, and in these a different method has been invented for almost every patient.

Mr. J. Basil Hall has contributed an interesting article upon the subject (*Ann. of Surg.*, vol. xxxvii. p. 481), and he has recorded a case of his own in which he used an ingenious method. He collected nine cases, including his own, with no deaths, but since then a few more operations have been performed. The following are some of the methods that have been employed.

In 1895 Kouwer (quoted by Basil Hall) used a lumbar incision and induced the formation of adhesions by means of tampons placed around it. This proved successful in one case, the spleen being well fixed four years later. The tampons had to be removed from another patient, because they produced symptoms of intestinal obstruction.

Rydygier, in 1895, made a pouch for the spleen, between the parietal peritonæum and the diaphragm upon the lateral wall of the splenic fossa; this he performed through a median abdominal incision.

Tuffier, Giordano, and Greiffenhagen have passed sutures through the parenchyma of the spleen and the parietes; severe hæmorrhage followed in Greiffenhagen's case. The spleen is so friable that all suture methods are to be condemned.

Bardenhauer made a vertical incision in the left flank, and separated the peritonæum from the parietes. He then brought the spleen out through a small opening in the peritonæum. This opening was narrowed round the pedicle, so that the spleen was retained in the subperitonæal tissues, and the wound closed over it.

Basil Hall fixed only the lower part of the viscus in the wound by narrowing the peritonæal incision and posterior rectus sheath, so that the edges gripped the spleen, at the narrow isthmus formed by a deep notch upon the anterior border near the lower pole. He also promoted the formation of adhesions by rubbing the peritonæum of the splenic fossa. The rectus muscle was brought over the prolapsed part, and the wound closed. The patient was completely relieved.

CHAPTER IX.

OPERATIONS ON THE LIVER AND BILIARY TRACTS.

OPERATIONS ON THE LIVER.

HYDATIDS.—HEPATIC ABSCESS.—REMOVAL OF GROWTHS OF THE LIVER.

OPERATIONS FOR HYDATIDS.

INCISION and enucleation will be described; the milder measures of puncture and electrolysis proved successful in many cases, but we do not know for certain how the death of the parasite was brought about by them in successful cases. At the present time these uncertain methods have been rightly abandoned, although they were useful in pre-antiseptic days, when they were much safer than the more radical procedures. The surroundings of hydatids of the liver are of truly vital importance, and sudden death has followed tapping more than once. Thus, in Mr. Bryant's case (*Clin. Soc. Trans.*, vol. xi. p. 230), while a hydatid cyst was being tapped, the portal vein, which had been pushed upwards and forwards by the projection of the cyst on the under-surface of the liver, was transfixed. Death followed in five minutes, and was thought by Dr. Fagge to be due to hydatid fluid being sucked into the vein as the trocar was withdrawn.

In a Russian case (*Lond. Med. Record*, 1885, p. 414) the pulse suddenly stopped while the cyst, which had been exposed by abdominal section, was being stitched to the incision. At the necropsy, a crumpled echinococcus had made its way into the right auricle, and a fragment of one into the right division of the pulmonary artery, by an opening between the thinned cyst and the inferior vena cava. Mr. Willett (*Brit. Med. Journ.*, Nov. 13, 1886) mentioned a case in which he had to aspirate a doubtful swelling of the liver. He used an ordinary-sized needle, and within two minutes the patient was dead. It turned out to be a case of malignant disease. No large vein had been pricked, and there was no hæmorrhage. The sudden, fatal syncope seemed due to the impression made on the nervous system through the solar plexus. Several other deaths from syncope have been recorded. Peritonitis, empyema, or subdiaphragmatic abscess may arise from leakage at the point of puncture after the withdrawal of the needle or trocar. Hydatid infection of these regions may also occur from the same cause. Suppuration in the sac occasionally took place even after taking all precautions against infection from the instruments employed.

(A) **Incision and Drainage.**—**Indications.**—This method is to be

preferred to enucleation when suppuration has occurred within or around the sac, when the latter is calcareous and adherent to vital structures, when severe hæmorrhage occurs, when it is important to complete the operation without delay on account of pulmonary complications, and when it is impossible to completely remove the disease. It may be carried out in one or two stages, but it is better to complete the operation at one sitting if possible. The operation is thus performed: The parts being cleansed and the other preliminary steps taken, the surgeon makes an incision about four inches long over the most prominent part of the swelling (previously carefully percussed) down to the peritonæum. This incision should, if possible, be made in front. Sufficient access may be usually obtained through one of the incisions used for exploration of the gall bladder (*vide* Fig. 211, p. 531). Even if a cyst or abscess shows its greatest point of prominence through the ribs, it should not be opened here unless it is quite certain that the pleural space is obliterated; moreover, the large drainage-tube needful necessitates resection of a portion of a rib. In rare cases the thoracic route is the best, when the hydatid is placed upon or near the convex upper surface of the liver. In these cases the liver may be reached below the reflection of the pleura, which may be displaced upwards (*vide* Fig. 212, p. 538). All hæmorrhage is next arrested, and the peritonæum is divided and secured with tissue forceps. The liver is now recognised, and sterile gauze tampons are carefully packed in on either side so as to prevent any escape of fluid into the peritonæal sac or over the parietal wound.

The needle of an aspirator or a fine trocar is then thrust in, and the existence of fluid beneath thus verified, and the fluid evacuated as far as possible. As the needle is withdrawn the liver is incised, and a finger quickly plugs, and then enlarges to an inch and a half, the opening made by the knife. Hæmorrhage, if free, is easily arrested thus, or by sponge-pressure. Escape of fluids into the peritonæal sac is prevented by the use of the tampons already mentioned, by an assistant keeping the edges of the wound carefully adjusted to the liver, and, lastly, by the next step, which consists in hooking up the opening in the liver with the finger, and in stitching the edges of the wound in the liver to that in the abdomen with a continuous suture of chromic gut. While inserting this, care must be taken to unite peritonæum to peritonæum, and to take up a sufficiency of liver-tissue by inserting the needle well away from the edges of the wound. As the sutures are inserted the tampons, &c., must be gradually withdrawn, and, if the fluid escapes very freely, it may be well to turn the patient over on one side. Any scolices which are within reach are next removed, and, if the cyst is firmly stitched and the patient's condition good, the contents and wall of the hydatid may be cleared out with sponges on holders, aided by scoops. All handling must be of the gentlest. A large drainage-tube is then inserted, and the usual gauze dressings applied.

Operation by Two Stages.—An incision, four inches long, is made through the abdominal wall over the most prominent part of the swelling. All bleeding having been carefully stopped, the peritonæum is picked up and slit open. The liver, recognisable by its characteristic colour, is at once seen moving with respiration. To make certain of the position of the fluid, a fine trocar may be now thrust in. If the

cyst be crammed with scolices, very little fluid escapes; if it be an acephalocyst, the fluid may spirt out under the high pressure not infrequently met with. After a few ounces have been withdrawn, any leaking is stopped by sponge pressure or suture, the parietal peritonæum is stitched to the edges of the wound by a few points of catgut suture, the wound plugged with strips of iodoform gauze wrung out of carbolic acid (1 in 20), and the dressings firmly bandaged on with a good deal of pressure so as to keep the abdominal wall as far as possible in contact with the liver.* On the third day the operation is completed by incising the liver, now well adherent, and inserting a large draining-tube. I have operated by both methods on patients of my colleagues Dr. Pye-Smith, Dr. F. Taylor, and Dr. Newton Pitt. All the cases did well, though in two the complete filling up of the cavity was very tedious. One, a woman, three months pregnant at the time of the operation, went her full time subsequently.

(B) **Enucleation.**—A number of cases in which the cyst has been enucleated from the liver have now been reported, and the success met with has been considerable. Thus Posadas (*Revue de Chirurgie*, March, 1899, p. 374) reports 23 cases, of which 19 recovered, and four died.

This method, which was first introduced by Mr. Knowsley Thornton (*loc. infra cit.*), is only suitable for some cases.

The tumour is exposed by a free incision, and isolated from the rest of the peritonæal cavity by means of tampons of iodoform gauze. After being emptied the whole endocyst is enucleated from the ectocyst and the liver; the cavity in the latter is then obliterated as far as possible by means of catgut sutures, and the abdominal incision sutured without drainage.

This operation is clearly much more severe than incision and drainage, and moreover the mortality (over 17 per cent.) is very much too high. It should, therefore, not be performed except under special circumstances, *e.g.*, when the cyst is single, small, near the surface, and not suppurating or calcified.

Pulmonary complications contra-indicate this operation, and severe hæmorrhage may prevent its satisfactory completion. Reaccumulation of fluid within the cavity has occurred in a number of cases, and suppuration in a few. Secondary drainage may have to be resorted to on these accounts. Therefore, it is wise to suture the liver around the incision to the parietal peritonæum before closing the wound. This also protects the peritonæum from risk of leakage and infection. Pedunculated hydatid cysts originating in the liver have been completely excised.

HEPATIC ABSCESS.—HEPATOTOMY.†

Tapping by a trocar, and draining the abscess by the cannula left in, or a drainage-tube passed through the cannula, the latter being then

* One case bulged out the right lower ribs most markedly. For reasons already given, I preferred to attack it in the front of the right hypochondrium. On exposing the liver, a hydrocele trocar passed through an inch and an half of hepatic tissue before fluid was reached. Very little hæmorrhage followed the completion of the second stage of the operation.

† This term is also applicable to incision of the liver for hydatids.

withdrawn, is unsatisfactory, for the following reasons:—(1) The cannula and tube may slip out. (2) The drainage is inefficient. (3) If the pus leaks into the peritonæal sac, it does so unseen. (4) The trocar may puncture important parts. Thus, in one case of Mr. K. Thornton's (*Med. Times and Gaz.*, 1883, vol. i. p. 89), the omentum, containing large veins, lay over the liver. (5) Puncture and drainage would be quite insufficient in cases where more than one abscess existed. When the circumstances are not favourable for a major operation and skilled assistance is not available, this method may still be found useful for deep abscesses. It is to a free incision, however, that we must look for a permanent cure. This may be employed in three ways:

1. Direct incision and drainage, when tenderness, œdema, and redness make it probable that adhesions exist. This needs no further comment. 2. Incision and drainage by abdominal section in two stages. 3. Incision and drainage by abdominal section at one sitting. When the patient is anæsthetised immediately before the operation, in doubtful cases, the liver should be explored with an aspirating needle of medium* size over any suspected area or through the eighth intercostal space in the axillary line. If pus be found the operation should be at once proceeded with.

The methods of treating an hepatic abscess by abdominal section, whether in one or two stages, have already been spoken of at p. 535, under the heading of Hydatids. They have the following advantages over other modes of treatment:—(a) The benefit of a free incision and thorough drainage; (b) the surgeon can see what structures he is dealing with; (c) bleeding from the liver can be seen and arrested; (d) pus can be prevented from escaping into the peritonæal sac by packing, &c.

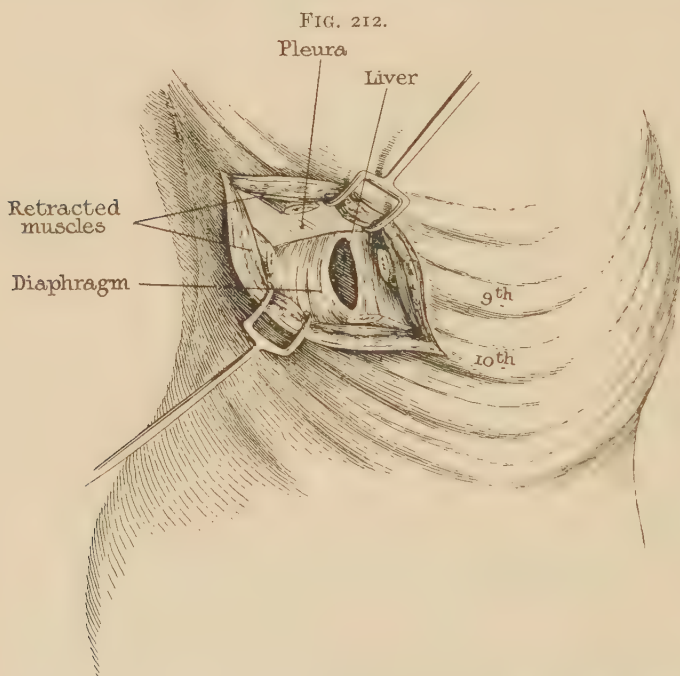
Very little need be said here of the treatment by abdominal section in addition to that already written at p. 535. In the two-stage method the surgeon will open the peritonæal sac, suture the parietal peritonæum to the edges of the wound, insert some gauze, and endeavour, by well-adjusted bandaging, to keep the abdominal parietes in contact with the liver, opening the abscess on or after the third day.

In the method by direct incision, a free incision of four or five inches is made and the parietal peritonæum united to the subcutaneous tissues of the wound. The position of the pus having been verified by a fine trocar or aspirator needle, tampons of iodoform gauze are carefully packed around. The abscess is then incised, and the opening at once plugged, and freely dilated with the finger. Any escape of pus into the peritonæal sac is prevented (1) by the careful packing; (2) by the finger hooking up the liver against the wound; (3) by an assistant keeping the parietes steadily against the liver. Hæmorrhage is controlled by forceps or sponge-pressure. When the abscess is empty† its

* It is essential for the needle to be of good size to allow the rather thick pus to flow. Sir Patrick Manson advises that, "at least, six punctures be made before the attempt to find it is abandoned" (*Tropical Diseases*, p. 369).

† The late Mr. Greig Smith (*Abdom. Surg.*, p. 527) advised that, if the abscess does not empty itself readily, a large tube lying in carbolic lotion may be pinched at the end, and when placed at the bottom of the abscess will act as a syphon. He also draws attention

opening is plugged with a sponge, and the liver and the parietes being still kept accurately together, the tampons first inserted are removed, and the edges of the liver wound stitched, with carbolised silk passed with curved needles on a holder, to the edges of the abdominal incision, care being taken to keep peritonæal surfaces well in contact. A large rubber tube is passed into the abscess cavity and fixed to the edges of the parietal wound by means of a salmon-gut suture. Care must be taken not to pass the tube too far in, lest it cause sloughing from pressure upon the wall of the abscess, which may be thinly separated



Exposure of the diaphragm and liver through the thoracic wall below the pleural reflection for hepatic and subdiaphragmatic abscess. The patient lies on his diseased side in the semi-prone position to avoid interference with the action of the healthy lung, and to prevent any chance of its bronchi becoming filled with pus or other fluid, which may escape during the administration of the anæsthetic.

from the peritonæum in places. A considerable thickness of dry gauze dressings will be needed at first, and will require frequent renewal. This will be facilitated by the use of a many-tailed bandage.

Treatment of Cases of Hydatid or Abscess of the Liver which have opened, or which threaten to open, into the Chest.—I refer here to those grave and difficult cases where a hydatid cyst or hepatic abscess, instead of making its way towards the abdominal wall, works upwards, thrusting up the base of the lung. Perhaps the first few

to the need of exploring the abscess cavity for signs of a second abscess, and, if this be found, opening it with the finger or dressing-forceps. All manipulations now must be of the gentlest for fear of hæmorrhage.

tappings have drawn off fluid from the front, but after this the cyst recedes from the epigastric region as in Mr. Owen's case (*loc. infra cit.*). In other and rare cases the cyst or abscess has been opened from the front or the side through the abdomen, but insufficient drainage is thus given. In such cases the advice given on p. 535 must be set aside, and the fluid must be drained through chest, and below the pleura if possible, in order to avoid the development of pneumothorax, and lessen the risk of infection of the pleural cavity (Fig. 212).

The pleura may be already adherent in suppurative cases. It may be remembered that the lower reflection of the pleura forms an oblique line running a little below the sixth rib in the nipple line, the eighth rib in the axillary, the tenth in the parascapular, and the eleventh at the spine. An incision may be so arranged that a portion of one or more ribs or cartilages may be removed and the liver exposed through the diaphragm below the pleural reflection, which may be displaced upwards if necessary. The same plan may be adopted also in the treatment of subdiaphragmatic abscess as recommended by Elsberg (*Ann. of Surg.*, vol. xxxiv. p. 729).

Mr. Godlee sutured the diaphragmatic and costal layers of pleura* round the edge of an aperture, made by removing a portion of rib, and then opened an hepatic abscess. Mr. Thornton, treating a similar affection with a view of obtaining a funnel through the pleura, along which the pus could escape safely, first raised the parietal pleura all round, so as to get a little free edge, then made a very careful longitudinal incision through the visceral pleura, raised it all round, and then with a fine curved needle united the two layers with a continuous fine silk suture. A channel being thus made, the liver-abscess was opened by a curved trocar, the puncture converted into an incision, and a large drainage-tube inserted. Mr. Owen, in the case of a hydatid cyst which encroached upon the thorax, incised the eighth intercostal space, first behind the anterior axillary line. As soon as the costal pleura was divided, air rushed freely in with a very audible sound, and, the finger being introduced, the diaphragm was at once felt bulging up along the inner surface of the ribs, while the lung had retired beyond reach. The intercostal space, which was fairly roomy, was forcibly widened, but it was not thought necessary to excise a piece of rib. The phrenic pleura and the diaphragm were then carefully incised, and the abdominal cyst was discovered. A certain amount of its contents were withdrawn by aspiration, so as to relieve its tension, and to permit of some of the face of the sac being drawn through the diaphragm, and across the shallow pleural cavity to the skin wound, to which it was secured by four harelip pins. The serous surfaces thus placed in contact were found firmly adherent on the fourth day. An incision was then made into the cyst, and a drainage-tube inserted. All three patients recovered.

* Mr. Godlee (*Brit. Med. Journ.*, 1887, vol. ii. p. 872), Mr. K. Thornton (*ibid.* 1886, vol. ii.), Mr. Owen (*Clin. Soc. Trans.*, vol. xxi. p. 78), and others have successfully adopted this course.

REMOVAL OF PORTIONS OF THE LIVER FOR NEW GROWTHS.

This operation will always remain a rare one from the infrequency of growths which admit of removal. Keen (*Ann. of Surg.*, Sept. 1899, p. 267) has, however, collected no less than 74 cases, in an important paper from which most of what follows has been gathered. The mortality has so far been only 14.9 per cent., so that the risk of the operation is certainly not a very serious one. Some idea of the variety of tumours that have been removed from the liver may be obtained from the following list which Keen gives:—Constricted, accessory, or herniated left lobe, five cases; syphiloma, 12 cases; carcinoma, 17 cases; adenoma, seven cases; sarcoma, five cases; angioma, four cases; cavernoma, one case; cystoma, one case; angio-fibroma, one case; small calculi, one case; endothelioma, one case; hydatid cysts, 20 cases.

Anschultz (quoted by Haubold, *Ann. of Surg.*, 1904, vol. xxix. p. 243) in 1903 analysed the records of 96 resections of new growths of the liver. Seventeen died from the operation; 10 were treated by excision, tamponade and pressure with one death: for seven the thermo-cautery was used, and all recovered. Of 25 in which deep ligation and excision were adopted, two died. And out of six in which preliminary clamping was used, two died. Of 21 done by intrahepatic ligature and excision, six died; and of 24 in which the elastic ligature was used, six died. In 12½ per cent. of the cases the resected mass was gummatous; two of these patients died. The ultimate results of resections for malignant growth have been very poor, only temporary relief having been afforded, and some delay of death in those who have survived the operation. To excise a gumma of the liver is both unnecessary and unjustifiable, except perhaps in some cases, where preliminary treatment with iodides and exploratory operation have failed to indicate the true nature of the tumour. Lockwood has successfully removed a Riedel's lobe for the relief of pain (*Lancet*, July, 25, 1903).

Ransohoff (*Med. News*, April 16, 1904) excised a mass from the liver, which upon microscopical examination proved to be tuberculous. The elastic ligature was used but this cut into the liver and caused profuse hæmorrhage next day. The growth was then removed with the cautery. The patient died a few days later of hæmatemesis of uncertain cause.

The chief difficulty met with is hæmorrhage; this has, however, been satisfactorily controlled, either by isolating the tumour by means of an elastic ligature before removal, or by dividing the liver-substance with the cautery, and ligating any large vessels met with while this is being done. Keen removed a carcinomatous left lobe weighing one pound and five ounces from a man aged 50, by the latter method, which he describes as follows:—

“The operation was done entirely with the Paquelin cautery. It took from twenty to thirty minutes to sever the left lobe from the remainder of the liver. The hæmorrhage was not very severe, excepting when I burned into some of the larger veins. Each of these, when opened, I was able instantly to close by my left forefinger. Then,

temporarily laying aside the cautery, I passed a catgut ligature under each by means of a Hagedorn needle, and one of my assistants tied it slowly but firmly. Five ligatures were thus applied. Three of the veins required ligatures of both of the divided ends. The hæmorrhage, except from these large veins, was arrested by the Paquelin cautery, except that occasionally, when I laid aside the cautery to apply a ligature, temporary packing with iodoform gauze was of great service in arresting the parenchymatous hæmorrhage." The cavity left was partially occluded by means of sutures, the remainder being loosely packed with gauze. Complete recovery took place.

In other cases the charred surfaces after suturing have been treated without drainage without any untoward result.

When the elastic ligature is employed, long steel pins are so placed as to prevent the ligature from slipping, and the tumour then removed half an inch beyond the ligature. The wound is then closed round the stump, which must be carefully kept aseptic. In a case treated successfully in this way by Mayo Robson, the pedicle left was as thick as the wrist, and after the separation of the slough a granulating surface was left. This gradually contracted, and the patient made a good recovery. One of the best ways of preventing hæmorrhage is to isolate the growth by means of stout catgut ligatures passed through and through the liver around the growth before the latter is excised (Anschultz).

THE SURGICAL TREATMENT OF CIRRHOSIS OF THE LIVER WITH ASCITES.—EPIPLOPEXY.

Professor Talma was the first to suggest this operation in 1889, "but to Mr. Rutherford Morison belongs the credit of having brought the first case to a successful issue" (Frasier, *Amer. Journ. Med. Sci.*, December, 1900).

Mr. Morison was quite unaware that anyone had previously suggested and already performed the operation when he first tried it, and published his paper in the *Lancet* of May 27, 1899.

In a later contribution (*Ann. of Surg.*, vol. xxxviii. p. 360) Mr. Rutherford Morison gives the following account of the way in which he was led to operate.

"I can now only claim, for Dr. Drummond and myself, that our views and treatment were entirely independent and original. His belief was that in certain cases of cirrhosis of the liver, ascites might be prevented by an increased circulation through the enlargement of normal channels between the portal and systemic veins. Mine, that if his explanation was correct, it might be possible to cure ascites by the formation of a new and accessory circulation, for which purpose I devised the operation described."

The normal communications between the portal and systemic veins are not at all free, and are practically limited to two situations as between the gastric and œsophageal veins at the cardiac end of the stomach, whereby blood may flow from the portal system into the azygos veins and superior vena cava. Sometimes these veins may greatly enlarge in alcoholic cirrhosis, and may rupture into the œsophagus and lead to fatal hæmorrhage.

(b) Between the superior hæmorrhoidal tributaries and those of the middle and inferior hæmorrhoidal, whereby portal blood may reach the iliac and even the axillary and subclavian veins through the superficial and deep epigastric veins.

So far there is very little evidence that any considerable venous anastomosis takes place through the adhesions formed between the omentum, liver, or spleen and the parietes, although it is stated that "in the case operated upon by Lens venous channels were easily found in the new adhesions which had formed between the omentum and the parietal peritonæum (Moynihan, *Abdominal Operations*).

It is more than probable that any good which may follow the operations which have been designed for establishing vascular anastomosis is really due more to the drainage carried out at the same time, and to the interference with the secreting function of the hepatic and splenic peritonæum.

Indications.—In view of some undoubted recoveries which have followed it, the operation of epiploxy is certainly worthy of consideration, especially when the grave prognosis of alcoholic cirrhosis under medical treatment is remembered. It is a mistake to think, however, that the disease is always fatal even after ascites has developed, and recovery may follow paracentesis in a few cases.

Epiploxy should certainly be reserved to early cases either before or soon after the onset of ascites; and in the absence of general debility, cardiac or renal disease and jaundice. Immediate cholæmia and early death followed the operation in an early case under the care of Dr. Fawcett, at Guy's Hospital. The patient seemed to be a favourable one for the operation, which was performed soon after the development of ascites. And in many other cases the results have been the same. Death may occur from shock, cholæmia, infection, or exhaustion.

If the operation is advised at all, the immediate dangers and the poor prospect of permanent relief should be honestly explained to those who have the ultimate responsibility of deciding for or against it.

Operation.—The abdomen is opened under general or local anæsthesia; the former is not sufficient in some cases, but the latter is especially dangerous in these cachectic patients. The incision is made above the umbilicus and near the middle line, a valvular wound being adopted. The fluid is drained and mopped away until the peritonæum is quite dry. As far as possible the peritoneal surfaces of the liver, spleen, and parietes are roughened by gauze friction, and the great omentum is extensively sutured to parietal peritonæum which has been rawed by friction. Catgut is the safest suture material to use. Drainage may be established through a stab-wound carefully made above the bladder and pubis, but unless great care be taken this may lead to septic infection sooner or later, and for this reason some surgeons prefer to dispense with it. The upper wound is carefully sutured in overlapping layers in order to avoid ventral hernia.

The omentum has been fixed in the parietal wound in some cases, but this is not to be recommended on account of the danger of hernia. Schiassi makes a vertical incision a little below the left costal margin opposite the middle of the clavicle, and another one running outwards from the upper end of the first incision. A triangular flap consisting of all the tissues down to the peritonæum is then raised, and a vertical

incision made in the peritonæum. The spleen and great omentum are withdrawn sufficiently to allow the surgeon to fix them in the wound, which is then sutured.

Results.—Mr. Morison's first case, like others before it, was unsuccessful, but the next, a woman, was relieved of her ascites and survived for two years, when she died from an operation undertaken for ventral hernia, the result of the former operation. Another successful case recorded by the same surgeon is quoted in detail below. Sinclair White also records two successful operations, the patients being both well a year after the operation (*Brit. Med. Journ.*, Oct. 10, 1903). On the whole, however, the operation cannot be said to have been a success. Out of 105 cases collected by Greenough, the mortality was 29·5, and only nine showed improvement after two years.

Out of six cases recorded by Harris five died within a month of the operation, and the other one, probably a syphilitic case, was alive but unrelieved after five months. It is fair to state that all these patients were in advanced stages of their disease at the time of the operation.

Koslowski found that 46 per cent. of 168 cases were either improved or cured after the operation.

Monprofit (quoted by Moynihan) collected 224 cases, in 213 of which the results were known. About 20 per cent. died from the operation, and about 20 per cent. died subsequently from cachexia or concomitant disease. Recurrence of the effusion took place in about 12 per cent. Improvement occurred in a little over 12 per cent., and recovery in about 33 per cent.

It may be safely concluded that these results, which refer to published cases, are far better than the real results of the operation, many failures being, as usual, buried in oblivion.

There is not enough evidence available at present to enable us to arrive at any accurate conclusion concerning the place and value of this operation, which is still decidedly upon its trial.

The following is a case of undoubted cirrhosis of the liver, in which a brilliant recovery followed an operation by Mr. Rutherford Morison:—

The patient was an alcoholic man, æt. 52, who had been tapped 14 times, 18 gallons and 2½ pints of fluid having been withdrawn in all, but without any permanent relief. Medical treatment and paracentesis having failed, the patient was admitted into the surgical wards of the Royal Infirmary, Newcastle-upon-Tyne. The following account is taken from the *Ann. of Surg.*, vol. xxxviii. p. 360: "On admission to the surgical ward his condition was described as follows: He was a thin man with sallow complexion, sunken cheeks, and yellow-tinted conjunctiva, his tongue was clean and moist, appetite fairly good, arteries slightly atheromatous, pulse ninety-two, and temperature normal. No jaundice or other disease discovered beyond what follows. His abdomen was much distended, and the physical signs were those of a large collection of free fluid; the left side of the scrotum was swollen from fluid distending a hernial sac. Dilated subcutaneous veins were visible, starting from the neighbourhood of the umbilicus, and terminating in one large trunk on either side, which ran up over the chest into the axilla. The direction of the blood current was ascertained to be from below upward. Percussion showed an increased splenic and diminished liver dulness. There was some œdema of the feet and legs extending as far as the middle of the calf. On Aug. 29, 1899, the patient was operated upon, under chloroform. An incision about four inches long opened the abdomen between the ensiform cartilage and the umbilicus. The subperitoneal fat was vascular, and bled

freely. A large amount of clear straw-coloured fluid escaped as soon as the peritonæum was divided. A second opening was next made between the umbilicus and the pubis large enough to admit a half-inch diameter glass drainage tube, which passed through and into the pelvis. Some adhesion was present between the liver and the omentum, and between the omentum and the abdominal wall. The liver was firm, finely granular on the surface, and of about normal size. The spleen was hard and enlarged to at least double its normal size. The abdominal cavity was dried with sponges, special care being taken to rub the surface of the visceral peritonæum opposed to them. The omentum was fixed across the anterior abdominal wall by catgut sutures. The upper incision was entirely closed by catgut sutures. The lower was kept open for a drainage tube, through which the fluid was pumped out of the pelvis. Over the dressings, broad long strips of adhesive plaster were applied transversely from the chest above to the drainage-tube opening below. This was for the purpose of keeping the upper part of the abdominal cavity empty of fluid and the parietal closely applied to the visceral peritonæum.

"Two nurses, with a reliable knowledge of antiseptic wound treatment, were told off to look after the tube, and keep any fluid from collecting in the pelvis or from escaping on to the dressings. The operation was well borne, and his recovery straightforward." From ten to twenty ounces of fluid were removed daily for the next fortnight or more, but on October 10 the tube was left out, for there was no fluid coming through it. Three weeks later he was readmitted and 230 ounces of liquid were removed.

"January 3, 1900: Better; signs of very little fluid in belly. From this date there was no further accumulation of fluid, and at the present time (February, 1903) he is very well, never looked better, is fat and strong, and has a good appetite. There are no signs of fluid in the abdomen. The veins in the abdominal wall are very large; he complains of some dragging pain in the abdomen; the liver can be felt adherent to the abdominal wall" (note by Mr. G. Grey Turner, Surgical Registrar).

OPERATIONS ON THE BILIARY TRACTS: CHOLECYSTOTOMY — CHOLECYSTOTOMY — CHOLEDOCHOTOMY — CHOLECYSTENTEROSTOMY — CHOLECYSTECTOMY — TREATMENT OF BILIARY FISTULA.

As the indications for these operations are nearly always gall-stones or their complications, it will be well first to briefly consider the different sites in which biliary calculi are met with and the chief evidence by which they may be differentiated, it being always understood that, as several of the following conditions may coexist, the symptoms to which a group of gall-stones in one position gives rise often runs into those of another. (i) *The calculus or calculi are in the gall-bladder.* The symptoms here will be chiefly recurrent attacks of colic, or a dull aching pain associated with local tenderness and often with pyrexia. No swelling may be present unless a calculus exists lower down, and for the same reasons there will be no jaundice. (ii) *The stone or stones are in the cystic duct.* Here there will be colic, and presence of a swelling having the characters of a distended gall-bladder. Jaundice is as a rule absent, but if a calculus in the cystic duct makes pressure on the common hepatic duct this point of guidance will be lost. (iii) *The calculus, one or more, occupies the common duct.* This, according to the duration of the mischief, will be more or less dilated, and the same applies to the tracts behind, unless other calculi are present here. In addition to colic, jaundice will be present, and if adhesions are forming, if any ulceration or septic process is going on, pyrexia may be present also. The gall-bladder, as pointed out by Mr. Terrier, Mr. Mayo Robson, and others, is usually contracted,

shrunk, and matted down by adhesions in these cases, so that no tumour will be present. Should distension of the gall-bladder be present in association with the symptoms mentioned above, it is to be looked upon as pointing rather to malignant disease than to the presence of gall-stones. Other points which may help in deciding between these two conditions are the time the trouble has lasted, the persistency of jaundice, and the age and general condition of the patient.

Mr. Mayo Robson (*Diseases of the Gall-bladder and Bile-ducts*) points out that calculi are more often situated in the common bile-duct than has been hitherto supposed, having found this condition in 39·4 per cent. of his operations performed for gall-stones. The same author also draws attention to the very important fact that multiple calculi in the common duct are more frequent than solitary ones. (iv) Very rarely stones may form in the hepatic ducts, but this is nearly always secondary to obstruction of the common bile-ducts.

In addition to the above it must be remembered that gall-stones are generally associated with inflammatory complications, which vary greatly, both as regards the parts involved and the intensity of the process. Even in the most simple cases some degree of adhesion from local peritonitis will be present, and in the more complicated cases the difficulties that the operator may have to face may be extreme. Some of these will be referred to later in the accounts of the various operations. The following may be mentioned as some of the special complications of gall-stones that may call for surgical intervention:—Empyema of the gall-bladder, abscess around the gall-bladder or bile-ducts, suppurative cholangitis, chronic catarrhal inflammation of the gall-bladder and bile-ducts, and phlegmonous cholecystitis.

An operation for gall-stones is usually, in the first instance, undertaken for exploratory purposes, the special operation which is called for being then undertaken, according to the conditions found to be present. The steps of the exploration will therefore be first described, and the details of the separate operations given subsequently.

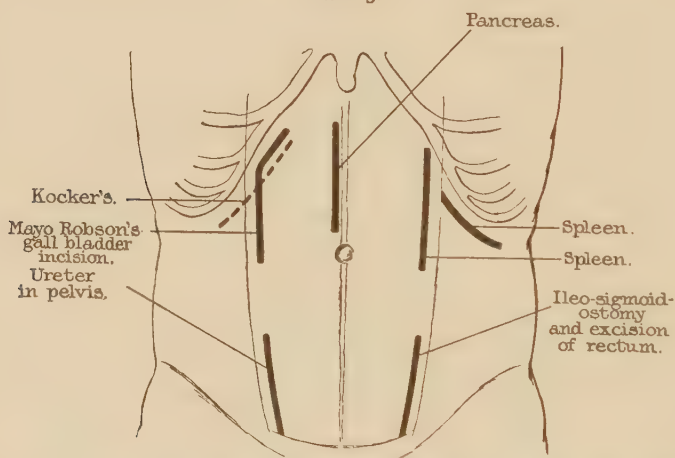
As a prophylactic against the troublesome hæmorrhage which is liable to attend operations upon patients suffering from jaundice, Mayo Robson (*Diseases of the Gall-bladder and Bile-ducts*) recommends the administration of chloride of calcium. He prescribes thirty-grain doses every four hours for a few days before operation, and continues the administration for some time after the operation, giving it either by the mouth or per rectum. Neither this nor gelatin have been found to have any certain effect in lessening the bleeding, and the only reliable method of avoiding it is by prompt ligation of all bleeding vessels during the operation.

Operation.—The patient is prepared in the usual way, and the skin is thoroughly cleansed and compressed on the preceding day. Every precaution is taken against shock. In order to render the parts more accessible, Mayo Robson (*loc. supra cit.*) places a firm, narrow sand-bag under the patient's back at the level of the liver. This brings the common duct two to three inches nearer to the surface, and also tends to open out the costal angle, and displace the intestines downwards away from the liver.

Moynihan (*Abdominal Operations*, p. 516) also advises tilting of the table so that the patient's head is several inches higher than his feet.

The anæsthetic will usually be the A.C.E. mixture or chloroform, ether being unsuited to many of these patients, often middle-aged and stout and flabby, and the subjects of chronic bronchitis. The abdomen having been cleansed again, one of the following incisions is made use of:—(1) A vertical one, over the prominence of any swelling present, or straight down from the tip of the cartilage of the ninth rib through the outer part of the sheath and fibres of the rectus muscle. It should be four inches long to begin with, and should be prolonged down to the level of the umbilicus if more room is wanted for the exploration of the common duct. This incision, if the wound be widely retracted, will answer in nearly all cases. Where the adhesions are very difficult to deal with, more room may be got by adding to an oblique incision

FIG. 213.



Incision for exposing the gall-bladder and bile-ducts. Various other incisions are shown.

carried inwards along the margin of the ribs at its upper extremity (*vide* Fig. 213).

Dr. Bevan (*Ann. of Surg.*, vol. xxx. p. 17) prolongs the incision, horizontally outwards at its lower end, but this step is rarely necessary.

In stout patients it is an advantage to make the wound in the skin and subcutaneous fat more extensive than the deep part through the muscle as recommended by Moynihan. The flabby superficial layers then fall away and diminish the depth of the wound.

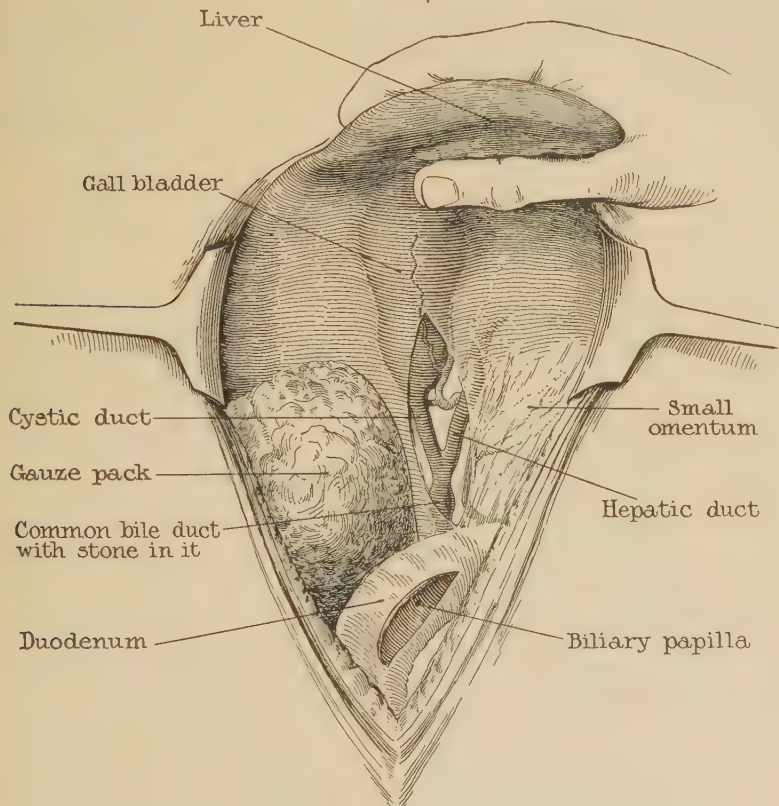
Professor Kocher uses an oblique incision about four inches long, running one-and-a-half inches below and parallel to the costal margin, and with its centre a little external to the outer border of the rectus. This gives a very good view and, from its high position, it is not likely to be followed by ventral hernia, if care be taken in suturing, although muscle fibres and nerves are cut across (Fig. 213).

Mayo Robson's incision is preferable and gives sufficient room in nearly all cases.* Any vessels which need it are secured with chromic

* Another useful incision which is always employed by some operators, and which is excellently suited for those cases where much difficulty is expected, is a transverse or

gut. The posterior layer of the rectus sheath and the peritonæum are incised together without any attempt to separate them from one another. A gauze pack is placed in the right kidney pouch to catch any fluid that

FIG. 214.



Exploration of the gall-bladder and bile-ducts. Choledochotomy and duodeno-choledochotomy.

may be set free; and an aseptic pad is inserted at the lower and inner part of the wound to protect the stomach and intestines (*vide* Fig. 214).

curvilinear one, starting a little below the tip of the ninth rib, at the outer edge of the rectus, and passing in a transverse or curvilinear direction into the loin; if extra room is needed it may be carried as far as the outer edge of the quadratus lumborum. This gives the best access of all, but we must wait for the results of cases which have been adequately watched before we can accept as certain the statement that the transverse incision is no more likely to be followed by a ventral hernia than is the vertical one, because it is in the upper and firmer part of the abdominal wall. This incision is recommended by Mr. R. Morison, of Newcastle-on-Tyne (*Ann. of Surg.*, August, 1895, p. 181). He gives the credit of it to Dr. John Duncan, of Edinburgh. Besides the excellent access which the incision gives, there is another advantage which will be given when the subject of drainage is considered. This incision is practically the same as Courvoisier's, much used on the Continent and in America—*viz.*, an incision about ten inches long, running obliquely parallel to the lower border of the right ribs, and about half an inch below them, with its centre lying over any swelling that is present.

The gall-bladder and bile-ducts are then carefully explored, with a view of deciding as to the further measures that may be necessary.

Omental and other adhesions generally require separating, and in doing this great care must be taken to arrest all hæmorrhage and to avoid lacerating any of the adherent viscera.

If possible, the liver should be pulled downwards and forwards into the wound, and then tilted so that its lower surface is displayed, as recommended by Mr. Mayo Robson (*loc. supra cit.*). The assistant should hold the tilted anterior border of the liver and the gall bladder, while the surgeon examines the bile ducts which are thus brought well forwards into view (*vide* Fig. 214).

CHOLECYSTOSTOMY.

If the gall-bladder is distended and free from adhesions, it is isolated by means of sterile gauze, then aspirated and opened.

If, on the other hand, the gall-bladder is small and shrunken and imbedded in adhesions, these must now be dealt with. The difficulties met with here may be due merely to omentum or distended intestines concealing the gall-bladder, or adhesions may have taken place about this structure to a varying degree. The following case of Mr. Robson's is a good instance of the difficulties which may be met with :

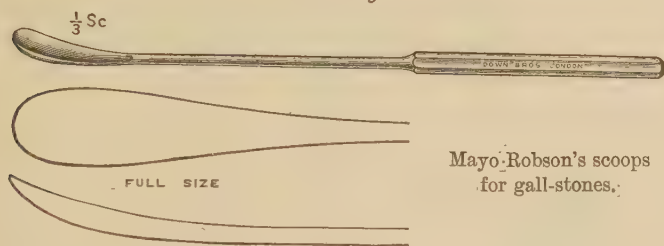
The tumour on being exposed "seemed to be composed of liver, gall-bladder, stomach, and omentum matted together. No fluctuation could be made out, and the tumour seemed so firm, hard, and nodulated as to give the impression of being malignant. An exploring syringe pushed deeply into the swelling simply withdrew a little blood ! but on pushing the needle through the overlapping edge of the liver, in the direction of the cystic duct, pus was withdrawn. On attempting to separate the liver from what was supposed to be the gall-bladder, pus began to well up, but fortunately none of it escaped into the peritonæal cavity, as sponges had been packed round the opening. On dilating the opening sufficiently to admit the finger, gall-stones were at once felt, one of which, about the size of a small walnut, was easily removed ; the second, impacted in the cystic duct, broke in removal, leaving the distal portion still within the duct : this was removed with considerable difficulty, as, on account of the matting of the parts, the finger could not be passed beyond the cystic duct to aid in its expulsion ; after its removal the index finger, on being pushed into the duct as far as possible, discovered another impacted stone, which it was found impossible to remove. As the sequel showed, this was perhaps rather a happy circumstance, for, on account of the depth, the friability, and the adhesions of the gall-bladder, it was found impossible to suture it to the surface, as the stitches would not hold ; hence, after the suppurating cavity had been washed out with a solution of fluosilicate of soda (gr. x. — Oj) and a drainage-tube inserted, the upper and lower ends of the incision were drawn together by silk sutures so as to somewhat limit the opening. The peritonæal cavity was left freely open, two sponges being placed on each side the opening into the gall-bladder so as to absorb any discharge flowing out of it. They were at first changed every two hours, antiseptic precautions being adopted. At the end of two days they were removed, one being simply applied directly over the drainage-tube, so as to press the parietal peritonæum into contact with the visceral."

The patient made a complete recovery.

In some cases the gall-bladder may be actually buried in adhesions, involving such structures as the abdominal wall, omentum, duodenum, and pylorus. The liver must be tilted and the intestines held aside with gauze tampons, so arranged as to shut off the general peritonæal

sac. A gauze pack must always be placed in the right kidney pouch, where any escaping liquid and blood will gravitate (*vide* Fig. 214). The adhesions are then most carefully separated with a fine blunt dissector (Fig. 136), a steel director, or curved scissors, bleeding, chiefly troublesome oozing from adhesions, being checked by ligature or by firm pressure with gauze. While this is being effected the operator must be prepared in some cases for an escape of pus, which has been shut in by these adhesions, outside the gall-bladder or the ducts lower down. In one case of Mr. Thornton's (*Brit. Med. Journ.*, 1886, vol. ii. p. 902),

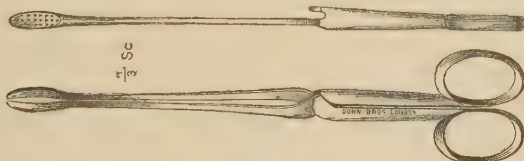
FIG. 215.



the majority of the stones—412 were removed—lay in a cavity in the liver substance. Through the liver-tissue which presented in the incision stones could be felt moving on each other: the gall-bladder was small and atrophied; a large stone occupied the common duct. Here the large stone originally in the gall-bladder had become impacted in the common duct, the other stones being formed in the hepatic duct and above it in the liver, where they gradually hollowed out a cavity.

The gall-bladder having been found and freed from adhesions, is

FIG. 216.



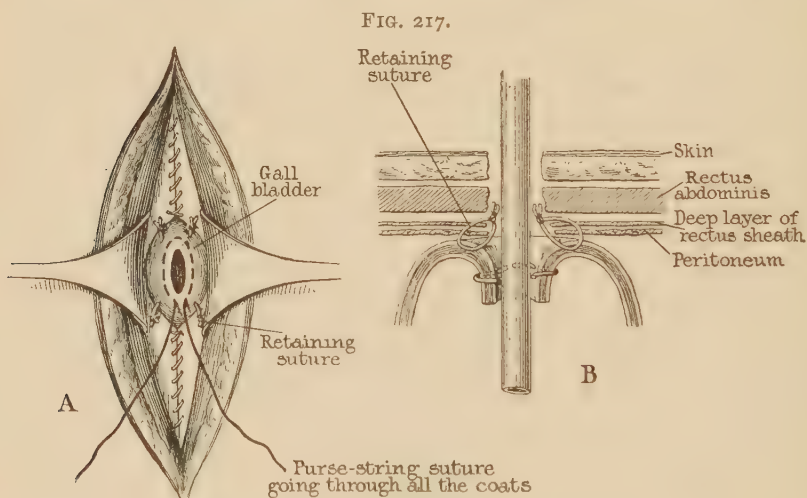
Anderson's forceps for the extraction of gall-stones. As the blades unlock, either can be introduced separately, and then used as a probe or scoop. In a difficult case these forceps are very helpful. (*Down's Catalogue.*)

brought into the wound if possible, and having been isolated by means of gauze tampons, it is first emptied by aspiration. The puncture is then enlarged and the gall-bladder held and steadied with forceps, while a forefinger is inserted to feel for calculi.

The gall-bladder having been steadied with forceps prior to any manipulations which may be needful—and the extraction of a stone fixed low down in the cystic duct is often a prolonged affair—any calculi which lie near the surface are removed with scoops (Fig. 215), dressing-forceps, or the forceps shown in Figs. 216 and 218. Of these I have found the one to the left of Fig. 218, though its blades appear

somewhat clumsy, very efficient in extracting stones when the ducts are dilated. Where a stone impacted low down in the cystic duct resists all efforts at extraction from the gall-bladder by scoops or forceps, attempts must be made to push it up into the gall-bladder by a finger introduced into the abdomen through the lower part of the wound. This, after the gall-bladder has been secured by sutures, is left open—kept plugged with iodoform gauze or a sterilised pad—so that a finger can be introduced from time to time to assist any instrument working from the gall-bladder, or to dislodge any calculus out of the cystic duct. If all attempts at removal or dislodgment fail, the calculus must be treated by choledochotomy or cholecystectomy.

In grave cases, especially with suppuration, the surgeon will have to be content with drainage of the gall-bladder. The calculus may



Drainage of the gall-bladder and fixation of it to the parietal peritonæum and deep layer of the rectus sheath. (After Summers.)

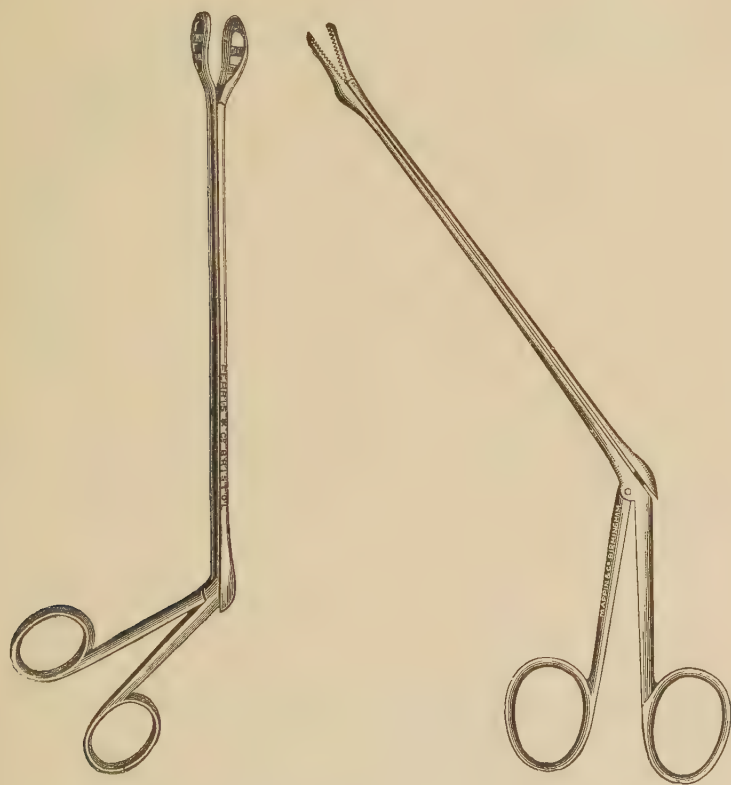
become dislodged spontaneously and be discharged externally. Injections have occasionally been successful in removing the stone. If the mucous fistula persist and cause serious inconvenience, a secondary operation may have to be undertaken for its treatment, under more favourable circumstances.

To drain the gall-bladder a rubber tube should be passed into it for about two inches and fixed in position by means of a purse-string suture piercing the sero-muscular coats of the gall-bladder, and the side of the tube. This procures inversion of the edges of the incision, and the serous surfaces become approximated on removing the tube, and the fistula closes rapidly. The peritonæal coat of the gall-bladder is then secured to the parietal peritonæum at several points, and the rubber tube is fixed to the cutaneous edge of the wound, in order to prevent its premature removal by any accidental traction upon it. The tube loosens and comes away after about a week, and the fistula rapidly closes if there is no obstruction in the biliary passages (*vide* Fig. 217).

In some instances it will not be possible to bring the gall-bladder

up to the abdominal incision and suture it there. Mayo Robson meets this difficulty as follows. He says, "it has at times been possible to tuck down the parietal peritonæum to the edges of the gall-bladder opening, and so to effect suture of the contiguous margins; but in several cases where this could not be done the right border of the omentum has been sutured to the margin of the gall-bladder opening and to the parietal peritonæum, thus forming a tube of peritonæum around the drainage-tube, and shutting out the general peritonæal cavity." If

FIG. 218.



Tait's cholelithotomy forceps. (Greig Smith.)

neither of these plans is available, a tube should be fixed in the gall-bladder by a purse-string suture, and surrounded with gauze packing. This will be found quite efficient in preventing leakage into the peritonæal cavity. In many cases it is best to excise the useless and contracted gall-bladder, and this is all the more justifiable because the thickened wall may be already in an early stage of carcinomatous disease. Several cases have been recorded in which the gall bladder has been discovered after its removal to be affected with malignant disease, although this was not even suspected at the operation. In rare cases dense adhesions may prevent the removal of the whole gall-bladder, and then the mucosa may be carefully dissected away from its surroundings.

CHOLECYSTOTOMY.

Here the gall-bladder is sutured at once after the extraction of the stones, *e.g.*, with a continuous suture of the mucous membrane, and then a row of Lembert's sutures, and returned into the peritonæal sac. This step has two grave objections. (1) It is not so safe as cholecystostomy, owing to the risk of leakage if the walls of the gall-bladder are at all inflamed and softened. This is just an instance of an operation where we hear of the successful, but never of the unsuccessful cases. (2) It is very difficult to be certain that all the ducts are patent. If a stone be left behind, suturing and returning the gall-bladder will give rise, in the immediate future, to dangerous tension on the sutures by the back-flow of the bile, while it prevents, later on, any attempts being renewed through the open gall-bladder. (3) When the gall-bladder is left after the removal of gall-stones, drainage is essential for the successful treatment of the chronic or acute inflammatory conditions, which partly cause and partly result from the lithiasis. For these reasons this operation has been deservedly abandoned, and it is only mentioned here to warn the too ambitious and unwary.

CHOLELITHOTRITY.

The term has been applied to crushing a gall-stone inside one of the ducts. The method was first adopted by Lawson Tait, who made use of forceps in order to crush the stone. Mayo Robson used to crush the stone by pressure between the thumb and finger; the fragments were then pressed on into the duodenum or washed through.

Cholelithotritry has been rightly abandoned, for it is uncertain, and may be incomplete. The bile-ducts may also be injured without the knowledge of the surgeon.

CHOLEDOCHOTOMY.

This term has been given to the operation of removing stones from the biliary ducts by direct incision. This method has gained ground very much of late years. Its safety in careful and competent hands has been established, and it has been proved that stones impacted deep in the cystic or in the common duct, which otherwise must have been left behind as persistent sources of misery or as causes of an open biliary fistula, extraction by opening the gall-bladder or cholelithotritry having proved impossible, can now be safely removed. The common bile-duct becomes smaller towards its termination, its diameter being about 8 mm. in the first part, 5 mm. in the second part, and $3\frac{1}{2}$ mm. in the intra-mural or third part, where it may be narrower than the cystic duct (Padula, *Ann. de Med. Navale*, November, 1903).

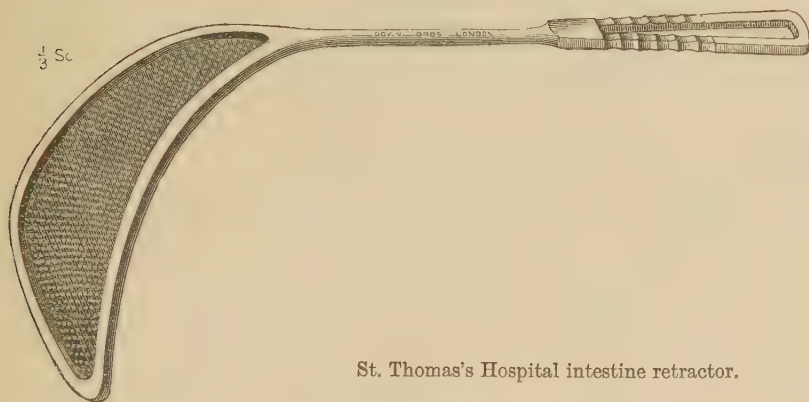
In its first part the duct is fortunately near the free edge of the lesser omentum in front of the portal vein and to right of the hepatic artery.

While the important relations of these ducts—especially the common—must always be remembered, the presence of the stone itself forms a reliable guide, as long as the incision is made directly over it. An inflamed lymphatic gland may be mistaken for a stone.

We will take the operation for removal of a calculus from the common duct. The preliminary exploration is described at p. 545.

(1) **Stone impacted in the First Part of the Common Bile Duct,** above the duodenum. The incision in the abdominal wall being lengthened if necessary so as to give satisfactory exposure of the parts concerned, the liver is held up, the edges of the wound are held widely open, and the position of the stone accurately defined. Large retractors (Fig. 219) may here be found useful in keeping

FIG. 219.



St. Thomas's Hospital intestine retractor.

back the intestines. The area of operation is then carefully shut off by sterile gauze packing (*vide* p. 547), and any adhesions over the stone are very carefully separated* while the duodenum is drawn down or turned aside. The stone, firmly held, is raised as high as possible. The incision is not to be made until the surgeon feels certain that he is directly over the stone. Two mattress sutures may be introduced into the wall of the duct before incising it. These

FIG. 220.



Moynihan's scoop and grooved probe.

serve to close the incision afterwards, and also act as guides (Mayo). The escape of bile, which is very profuse, and usually infective, if it

* The importance of patience and care in separating adhesions is shown by the fact that even in Mr. Mayo Robson's experienced hands faecal extravasation took place from a small perforation in the colon, caused by the separating adhesions during the removal of a stone from the common duct, the injury being unrecognised at the time. Another instructive case is that of Ross (*Canadian Practitioner*, April, 1894). Here several stones were lodged in the common duct, the duodenum was accidentally torn, and this opening was enlarged in the hope of reaching the stones through the opening in the duct, but this point could not be found. The common duct was accordingly opened and the stones removed. The duct was sutured, but owing to the friability of the tissues at the site of the roughened stone, it was impossible to prevent the leakage of bile. Drainage was employed with iodoform gauze. The bile continued to flow, but increased suddenly after vomiting, and the case ended fatally fifty-six hours after the operation.

has been long pent up or if the blocked duct is dilated, must be met by assiduous sponging and careful packing of the kidney pouch of peritonæum.

After removal of the main stone the ducts must be thoroughly and systematically explored, for, as has already been pointed out, there are usually several stones present, and the failure to remove them all will render the operation useless in late cases of obstruction of the common duct. Stones may have formed in the hepatic ducts, and may be overlooked, and give rise to recurrence of symptoms. This exploration should be carried out with the finger if the ducts are sufficiently dilated, or failing this, by a bent probe or small scoop (*vide* Fig. 220). The finger, however, should be employed wherever possible, because it is the only really certain method. Mayo Robson strongly emphasises this point, and mentions a case in which a probe and scoop failed to discover a stone which was found afterwards on digital examination. The probe should be passed into the duodenum to make certain that the ampulla is patent.

The ducts having been cleared, it remains to consider the different means of treating the opening in the duct. If the passages above and below are patent, if the opening is accessible, and if the patient's condition admits of further prolonging of the operation, sutures should certainly be employed for the additional security which they give.* The escape of bile being prevented by the pressure of the fingers above the opening, the incision by which the stone has been extracted is closed by a continuous suture of catgut for the duct itself, while a second set of sutures of silk are used to draw together the cut edges of the overlying peritonæum. The sutures are best inserted by a small curved needle held in pressure-forceps, by Mr. W. A. Lane's cleft palate needles held in his special needle-holder (*vide* Fig. 221, Vol. I.), or, as recommended by Mr. M. Robson, by a rectangular cleft-palate needle. The value of a free incision, opening up the wound in every direction, tilting the liver, drawing down the duodenum and colon, and, perhaps, the use of an electric lamp, will be very apparent now. The assistants must be assiduous with well-applied sponge-pressure. In the words of Dr. Binnie, of Kansas City (*Ann. of Surg.*, November, 1894, p. 563), "a difficulty which occasionally confronts the surgeon is to distinguish at the bottom of a deep and narrow pit the wounded duct from oozing adhesions recently divided."

Dr. Halsted (*John Hopkins Hosp. Bull.*, April, 1898) recommends the use of a small metal hammer in order to facilitate the introduction of sutures. The head of the hammer is made in a variety of sizes, and is fitted with a long slender handle (Fig. 221). The hammer chosen should be large enough to fully distend the duct. The head of the hammer is passed through the incision in the duct, and serves to steady the latter and also to lift it up towards the surface while the sutures are passed. The hammer is then removed and the sutures tied.

With advantages of a free incision, arching of the back, tilting of the liver, and good assistance, the suturing is not so very difficult, and but few, if any, surgeons now use the hammer.

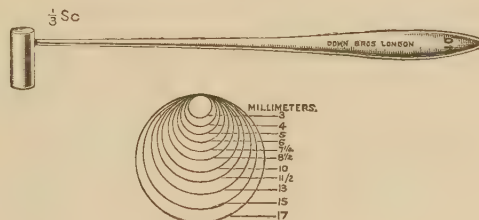
* Even if the sutures do not hold, they do good by preventing or lessening the escape of bile while adhesions are forming to shut off the peritonæal sac.

In many cases, it is not advisable to close the incision in the common bile-duct, especially if there is septic cholangitis, and if the gall-bladder is not available for drainage. A tube may be tied in the root of the cystic duct when the gall-bladder has been removed. Many surgeons prefer to dispense with sutures, as a rule, because of the safety and the beneficial effects of drainage, and the risk of narrowing of the passage by suturing.

Drainage.—It will be safer always to use this in some form or other* whenever the ducts have been incised, but with more elaborate precautions, of course, when no sutures have been inserted. To take the latter case first.

A rubber tube is passed upwards towards the hepatic duct, and secured in position by means of a catgut suture, which pierces the side of the tube and the edges of the wound in the duct. To prevent contamination of the peritonæum, a rubber tube surrounded with a layer of gauze, and containing a gauze wick which projects at both ends, is passed into the kidney pouch below and outside the wound in the common bile-duct. In some cases drainage may be established through a stab wound into the loin. Mr. Rutherford Morison, of Newcastle, has

FIG. 221.



Halsted's hammer.

drawn attention to the importance of draining the kidney pouch (*Brit. Med. Journ.*, vol. ii. 1894, p. 968). He there shows that in the right hypochondrium, between the liver and the colon, is a natural space with barriers which separate it, more or less completely, from the general sac. Bile may be allowed to escape into this space as long as it is efficiently drained by an incision made through the posterior parietes immediately below the lower end of the right kidney. If the curved incision which Mr. Morison and others recommend be made use of, the drainage-tube will be in the lower and outer angle of the wound.

If the method which has been described above be followed it will be rarely necessary to drain directly through the loin, and this additional wound can be safely dispensed with except when suppuration exists.

Dr. R. Abbe, of New York, recommends the method of drainage shown in Fig. 222, which he has used successfully (*loc. supra cit.*). A

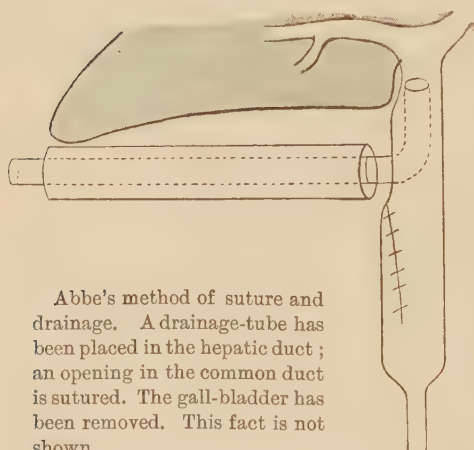
* It has been stated that drainage is not needed, as pure bile does not excite peritonitis. I am of opinion that the surgeon can rarely tell for certain whether the bile is pure or not. Certainly in cases where there have been repeated attacks of cholelithiasis with pyrexia it is extremely probable that the bile is infected from the intestines—*e.g.*, with the *bacillus coli communis*. And this is the more likely when any part of the ducts has been long dilated into a large sac.

stone having been removed from the common duct, a large drainage-tube was passed into the hepatic duct through the opening in the common duct, this opening being then sewn up with fine silk. Around the tube which emptied the hepatic duct a larger one was placed, reaching to the common junction, and a light iodoform tampon was finally pushed in. All the bile came through the tube for five days; the inner one was removed on the second day, and the sinus closed in three weeks, the patient making an excellent recovery.

If the flow of bile is profuse, syphonage may be adopted, the fluid being conducted into a basin at the side of the bed. In that case it is wise to fix the tube to the skin, so that it may not be accidentally dragged and displaced.

The tube will become detached in about a week, and may be removed.

FIG. 222.



Abbe's method of suture and drainage. A drainage-tube has been placed in the hepatic duct; an opening in the common duct is sutured. The gall-bladder has been removed. This fact is not shown.

The larger tube draining the kidney pouch may be gradually withdrawn from the fourth to the eighth day.

Where the opening has been closed with sutures it will still be wise to use a wicked drainage-tube for a day or two, the indication for this being clearer in cases where the suturing has been attended with difficulty, where the edges of the duct are much bruised, and where any contraction may exist in the biliary passage below.

The surgeon may also make use of some of the adjacent soft parts to act as

a dam between the duct and surface, and so prevent the bile from entering the peritonæal sac, or he will employ drainage and iodoform gauze. Amongst the soft parts that are handy, the omentum at once presents itself as the most available. Mr. Mitchell Banks (*Liverpool Med.-Chir. Journ.*, 1893, p. 307) in a case of cholecystostomy, in which the incision in the gall-bladder could not be united to that in the abdominal wall, made use of "the round ligament of the liver and some neighbouring omentum, which he fastened to the gall-bladder, and succeeded in so banking it up as to prevent the bile from flowing into the peritonæal cavity." Binnie, of Kansas City (*loc. supra cit.*), made use of separated adhesions after extracting a calculus through the opened cystic duct.

"Suture of the wounds in the bladder and the duct might have been possible, but as it would certainly have taken much time, I decided to drain, but at the same time to build up of omentum, mesentery, and existing adhesions, a diaphragm between the track of the drain and the general peritonæal cavity. Thus the wounded biliary passages were left open. A few stitches of catgut, judiciously placed, bound together the various structures above mentioned in such a way that in a few hours they became an impervious rampart of adhesions. . . . A rubber drain was also passed to the bottom of the wound, and surrounded throughout its whole length with a liberal supply of iodoform gauze."

(2) **Stones impacted in the Second Part of the Common Bile-duct** behind the duodenum and the head of the pancreas* or within the latter.

If possible the stone should be pushed upwards into the first part of the duct, whence it can be more safely and more easily removed. Failing this, the duodenum may be mobilised by incising the parietal peritonæum about an inch to the right of the descending part and turning the latter forwards and inwards (p. 474).

The calculus is sought, and if found it serves as the best guide to the duct, which may be embedded in the head of the pancreas, which may have to be incised. When the stone has been found it may be possible to push it back into and remove it from the supra-duodenal part of the duct as adopted by Lane (*Clin. Soc. Trans.*, 1894, p. 149). If this is not possible the duct must be incised, and calculus removed, and drainage always established. Berg (*Zeut. f. Chir.*, 1903, No. 27) recommends this method in preference to duodeno-choledochotomy.

The objections to this route are that it is difficult and may be accompanied by severe hæmorrhage from the pancreas. Moreover, the duodenum or even the vena cava, which lies behind the duct, may be lacerated if there is much matting from chronic inflammatory changes.

In such cases it is easier and safer to adopt the trans-duodenal route, as Kocher did in one case, on account of severe hæmorrhage from the pancreas, which made him give up the retro-duodenal route. Wounds of the pancreas are always to be avoided if possible (*vide* p. 570).

(3) **Stones impacted in the Ampulla of Vater — Duodeno-choledochotomy** (*vide* Figs. 214, 223).—Dr. McBurney was the first to perform this operation in 1891. He lays stress upon the following procedure:—

“In all cases which are not complicated by very deep adhesions, involving the common duct and descending portion of the duodenum, it is easy and very desirable after determining the presence of a calculus in the lower part of the duct to pass the left forefinger through the foramen of Winslow to a point behind the calculus. With the finger, the lower end of the common duct, the calculus, and the descending portion of the duodenum, can be lifted forward so as to bring these parts nearly or quite to the level of the abdominal incision.† The duodenum is then incised in its anterior wall for from one to one inch and a half, the orifice of the duct (which is usually markedly altered as to the colour, &c.) is easily found and enlarged with knife or scissors or forceps, and the stone removed. All of this, and even suture of the intestinal wound, should be completed without removing for a moment the left forefinger from its supporting position” (Dr. Hancock, *Ann. of Surg.*, vol. xliii. p. 72) (*vide* Fig. 223).

When an incision is made through the posterior wall of the duodenum into the common bile-duct before it becomes intra-mural, as in

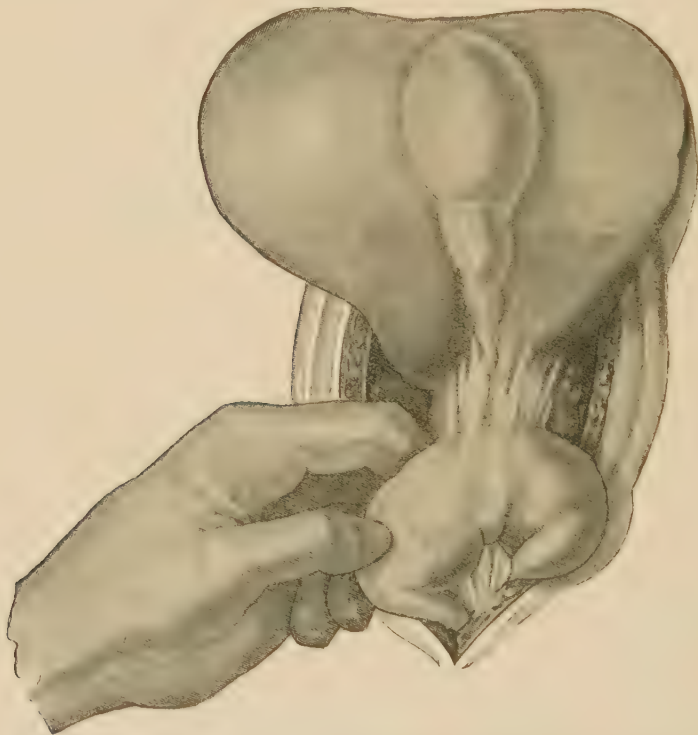
* A stone impacted in the duct, low down, may give a hard or nodular feel which may suggest malignant disease of the head of the pancreas; an exploring needle will clear up the case.

† If the duodenum is not mobile enough, the peritonæum to the right of it may be incised to the required degree (p. 474).

Kocher's case, extravasation of bile may occur into the retro-peritonæal tissues, unless the incision in the duct is accurately sewn, as advised by Kocher, when the papilla is patent; if any obstruction exists at the orifice, the edge of the incision into the bile-duct should be sutured to those of the wound in the posterior wall of the duodenum, thus establishing a fistula between the gall-duct and the duodenum.

If an incision has been already made into the common bile-duct in its first part, a piece of gauze may be drawn downwards from it to the

FIG. 223.



Duodeno-choledochotomy; stone in the common duct low down. The duodenum has been freed and brought to the surface preparatory to being opened. (Moynihan, *Abdominal Operations*.)

duodenum, thus removing any debris (Mayo and Kehr); but if free drainage is established into the duodenum, it is not necessary to make a separate incision for drainage of the common bile-duct. A scoop must be passed upwards along the bile-duct to prove the absence of stones higher up before the duodenal incision is closed in the usual way with two continuous sutures.

The disadvantages of the operation are—

(1) It is difficult; but when a stone is impacted near it, the biliary papilla is easy to find.

(2) In two of the 62 cases collected by Hancock, a duodenal fistula formed, and in one of these it led to the death of the patient from

exhaustion; in the other the leakage spontaneously ceased. With careful suturing a duodenal fistula should be avoidable.

(3) It has a higher mortality than choledochotomy. Infection of the peritonæum from the duodenal opening should be avoidable by careful preparation of the patient and skilful operating.

The advantages which have been claimed are that—

(1) Drainage through the cutaneous wound is unnecessary.

(2) It is easier to sew up an intestinal wound than one in the bile-duct.

(3) The intestinal wound heals more quickly and satisfactorily.

(4) The trans-duodenal route gives an easy and natural access to the common bile-duct in its lower part.

(5) The biliary papilla may be enlarged if stenosed.

(6) A new growth or pancreatic stone in the ampulla may be discovered to be the cause of symptoms, and may be removed.

This method being more severe and dangerous than opening the bile-duct above the duodenum, is, of course, only suitable for cases in which it is found to be impossible to remove the obstruction in the usual way.

Dr. Hancock (*loc. supra cit.*) has collected the records of 62 trans-duodenal operations; 57 of these were for the removal of gall-stones, three for pancreatic calculi, and in two new growths of the papilla were found. The mortality of the 62 operations was 12·6 per cent., and that of the 57 undertaken for gall-stones was 8·77 per cent. The death-rate from this operation will probably be always higher than that of choledochotomy, because the cases demanding it are often later, and the operation in itself is more severe.

CHOLECYSTENTEROSTOMY.

In this operation a communication is made between the gall-bladder and the small or large intestine. Whenever feasible the duodenum or upper jejunum should be preferred. When the small intestine is too matted by adhesions to come up sufficiently, the hepatic flexure of the colon should be chosen. Mayo joined the gall-bladder to the transverse colon in five cases in which he was unable to use the duodenum, and the results were excellent. Cholecystenterostomy received great impetus owing to the recommendations which it received from Dr. Murphy, of Chicago, the facility with which it can be performed with his most ingenious and expeditious button, and the good results which the published cases show. The chief indications for the operation are—

(1) Irremediable obstruction of the common duct, due to calculus or cicatricial contraction. The operation should be rarely required for calculous obstruction, for it is much better to remove the obstruction if possible. In some cases this may not be practicable, or the condition of the patient may make the attempt inadvisable. Leaving the stones may lead to suppurative cholangitis or to the development of malignant disease. The second cause is very rare, and it is probable that as time goes on, and surgery proves what can be done for calculi impacted here, this indication will very rarely arise.

(2) In irremovable obstruction of the cystic duct, where cholecystectomy is impracticable.

(3) A persistent fistulous opening after operations on the gall-bladder, or due to stricture, or occlusion of the common duct, giving rise to a constant escape of bile, causing persistent excoriation and annoyance, owing to the eczematous rawness. In such cases the operation of cholecystenterostomy was recommended twenty years ago in this country by Mr. Willett (*Brit. Med. Journ.*, vol. ii. 1886, p. 903).

(4) Mayo Robson also gives chronic pancreatitis.

(5) Another indication which has been sometimes given is malignant disease about the head of the pancreas, occluding the common duct and giving rise to jaundice, itching, &c. In such cases cholecystenterostomy must involve greatly increased risk. Hæmorrhage and imperfect repair are the chief dangers, the first especially so, as will be seen from the case given below of Dr. F. J. Shepherd, of Montreal (p. 562). Dr. Murphy himself (*Chicago Clin. Rev.*, February, 1895) considers the operation here very unsatisfactory, there having been seven deaths out of eight cases. Two died from shock, one from a twisting of the small intestine, before the approximation was made, a volvulus being thus produced. In another case the gall-bladder was so friable that it tore like wet paper when the sutures were inserted, and after the bottom was in position and the abdomen closed, the friable wall gave way, and peritonitis followed. Dr. Murphy accordingly advised that if the operation be made use of in case of obstruction due to malignant disease, it should only be in the early stage.

Cholecystenterostomy may not be practicable with a contracted gall-bladder, and it may be very difficult or impossible to bring any part of the intestine up without kinking when adhesions are dense and diffuse. In such cases the gall-bladder may be joined to the anterior surface of the stomach without any ill effect from the discharge of bile into the stomach. Perrier (quoted by Moynihan) collected seven recorded cases of cholecystgastrostomy, with six recoveries.

The indications for cholecystenterostomy having been given, the means of performing the operation will next be considered. These are—

(1) Suture alone. The gall-bladder is first emptied by aspiration and then joined to the intestine with the aid of clamp forceps and two continuous sutures, as in the operation of gastro-jejunoostomy (p. 506). The aperture should be made at least an inch long, and catgut should be used for the deep suture.

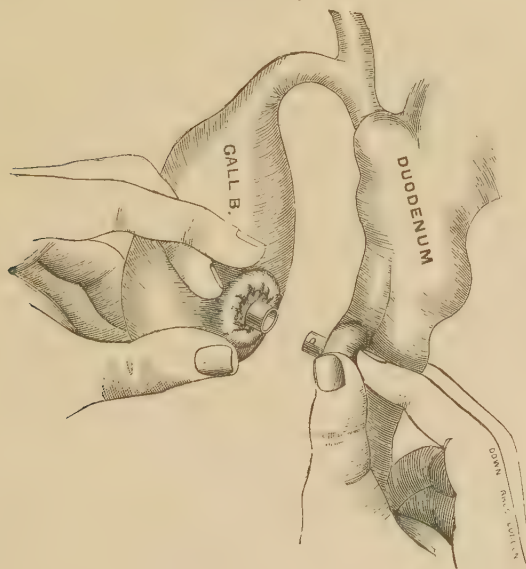
(2) Mayo Robson's bobbin. This is inserted in the manner already described under "Entero-anastomosis" (p. 373).

(3) Murphy's button. Cholecystenterostomy by this method requires careful attention. The attractiveness which the simplicity of this most ingenious device must always carry with it, the success* which it has met with in skilful hands, make it very probable that, in the zeal of securing an immediate success, this operation may be performed, if it has not already been so, much too often. Thus, to take both sides of the question, on the one hand we have these *advantages*: the two viscera which are to be united are often readily reached by a comparatively small incision. The button is very quickly adjusted, the bile soon

* Dr. Murphy, in a report up to 1897, gives 67 cases of cholecystenterostomy for non-malignant obstructive jaundice, with only three deaths, but ten out of twelve malignant cases died from the operation.

passes by the new channel, the jaundice and itching are lost and the fæces again become natural. On the other hand the following *objections* present themselves to every candid and well-informed thinker. (1) It is clear from the account of several of the cases that the cause of all the trouble might have been removed, and not only relieved. Thus, in several, stones were not removed from the gall-bladder, and the ducts were not even examined.* Yet these cases are published as successes. As this operation, rendered so simple by Murphy's button, is likely to be resorted to in cases of stone impacted in the three bile-ducts, it is right to point out that modern methods and recent experience have rendered removal of stones by incision so safe in skilled hands that this step, choledochotomy, is always to be preferred, when possible, to

FIG. 224.



Cholecystenterostomy with Murphy's button. (Down's Pamphlet.)

cholecystenterostomy. In other words, those of Dr. McGraw (*Ann. of Surg.*, Aug. 1895, p. 169), "we should try not only to relieve, but also to cure." (2) Another objection, though, I believe, only proved by a few cases as yet, is that of septic infection of the ducts and liver from the intestine. We must remember how very different are the conditions after cholecystenterostomy, to those in health, as regards a communication between the intestine and the biliary passages. That a patient after this operation, as long as the opening remains free, must be menaced with the danger of septic infection is proved by a case

* Dr. McGraw, of Detroit, and Dr. Elliot, of Boston, both bring a further objection against the button consequent on this, that it often leaves behind it in the form of a stone or stones, sources of irritation, which may develop later into conditions of danger. Time must show, with careful watching and accurate reporting of cases, how far this criticism is justified.

reported by Rickard (*Bull. Soc. Chir.*, t. xx. 1894, p. 572). Here death occurred fifty-three days after cholecystenterostomy, although the patient did well at first. The necropsy showed that death was due to infection of the biliary passages from the intestine, numerous abscesses due to ascending infection being present. (3) There is the risk of contraction. Unless the opening is made very free, this may set in after any method. (4) Hæmorrhage. This risk must be present, however cholecystenterostomy is performed, in cases of obstruction from malignant disease, owing to the tendency to hæmorrhage in these cases; it is especially likely to follow the use of Murphy's button, whenever a thickened condition or friability of the tissues prevents the button taking that grip which is so essential for success. All surgeons owe much to Dr. F. C. Shepherd, of Montreal, for the candid way in which he has drawn their attention to this fact (*Ann. of Surg.*, May, 1893, p. 581):

His patient, aged 36, had a biliary fistula resulting from a previous cholecystostomy for jaundice, pain, &c., performed four months previously, when no stone was found. Owing to the annoyance of the continual discharge of bile, the abdomen was opened again by an incision internal to the old fistula, and a mass of malignant disease was now found involving the pancreas and duodenum. It was decided to unite the gall-bladder with the colon instead of the duodenum, "as being easier and more rapid, and quite as beneficial." The button was introduced without very much difficulty, the purse-string suture being first inserted. Owing to the thickness* of the gall-bladder there was some puckering, and the parts did not come together without considerable pressure on the button. On dropping back the bowel and gall-bladder with the button there was no tension, and the parts seemed to be in accurate apposition, and to lie comfortably. It was decided not to close the fistulous opening, as it was felt that this would close of itself. On the morning of the fourth day (the patient having gone on well in the interval) blood was found to be oozing from the gall-bladder and the abdominal wound. In spite of gauze-packing this continued, and the patient passed into a state of collapse. On opening the abdominal wound it was seen that the hæmorrhage came entirely from the gall-bladder. The button had cut through the thick and friable walls, and could be easily seen. To remove the button it was necessary to incise both gall-bladder and bowel and unscrew the button. It being useless to reinsert the button, it was decided to sew up the openings in the gall-bladder and colon. A fresh oozing took place about twenty-four hours later, and the patient sank. A partial necropsy showed that the obstruction of the common duct was due to malignant disease of the head of the pancreas.

(5) The button may not be passed. This happened in a case of Dr. Briddon's (*New York Surg. Soc.*, 1896). Here the bladder was dilated with non-contractile walls. The button probably fell into this viscus as the larger chamber, and there remained, two months later, without causing inconvenience. Two other objections are brought against cholecystenterostomy by Dr. McGraw. (6) It produces adhesions between previously detached organs, adhesions which may interfere with their movements and with their actions. (7) After this operation the bile is diverted through the cystic duct and gall-bladder into the bowel. The gall-bladder takes on itself the function of the common duct, and the common duct, remaining patulous at its upper end, receives a certain amount of bile which stagnates under conditions

* It will be noticed that no mention is made of the gall-bladder being friable, the condition which was found, a little later, to have contributed so largely to the fatal result.

which favour its crystallisation, especially if, as is often the case, the common duct already contains stones.*

Of the three methods above mentioned, however, that by means of Murphy's button, in spite of the above objections, is probably the best to adopt on account of its rapidity and efficiency as shown by the results given above. The operation itself is similar to others in which the button is employed, and does not require any special description.

Owing to the small size of button used, there is little or no danger of intestinal obstruction supervening.

It seems to me to be quite unnecessary to exclude the part of the intestine which is joined to the gall-bladder, with the object of preventing the intestinal contents from reaching the gall-bladder. Moynihan in one case adopted this plan, using what is practically an adaptation of Roux's method of gastro-jejunostomy. Mikulicz suggested the anastomosing the limbs of the loop of intestine which is joined to the gall-bladder. Not only are these complications superfluous, but they are both impracticable except when the jejunum is used, which is certainly not the best part to choose for several obvious reasons.

Choledoch-enterostomy.—This operation may be performed in much the same way as cholecystenterostomy, a fistula being established between the contiguous parts of the dilated duct and the duodenum or other available part of the intestine. The gall-bladder may be so small and embedded in adhesions from long standing disease, that it may be either entirely overlooked or may be of no use for short-circuiting. In a recent case one of us (R. P. R.) joined an enormously dilated common bile-duct to the anterior surface of the first part of the duodenum by direct suture with the aid of clamp-forceps used as in gastro-jejunostomy. The obstruction was due to a calcified pancreatic cyst which had completely obstructed the lower part of the duct.

CHOLECYSTECTOMY.

The indications for this operation as given by Mayo Robson (*loc. supra cit.*) are as follows: "(1) In bullet wound or other wound of the gall-bladder where suture is impracticable. (2) In phlegmonous cholecystitis. (3) In gangrene of the gall-bladder. (4) In multiple, or in perforating ulcers. (5) In chronic cholecystitis from gall-stones, where the gall-bladder is shrunken and too small to safely drain, and where the common duct is free from obstruction. (6) In mucous fistula due to stricture of the cystic duct. (7) In hydrops of the gall-bladder due to stricture of the cystic duct; as also in certain cases where the gall-bladder is very much dilated. (8) In certain cases of empyema, where the walls of the gall-bladder are very seriously damaged. (9) In cancer of the gall-bladder." To avoid this, gall-stones should be treated with less delay, for their long-continued irritation very frequently leads to the development of carcinoma.

* "Here then we have the beginning of a morbid condition of which no man can foresee the end. There is no reason why, in the course of time, the obstructed duct may not become full to overflow with numberless gall-stones which could not fail in this receptacle to cause fully as much disturbance as in the gall-bladder itself." Only careful watching of cases can prove whether the above criticisms are true. Those surgeons who are familiar with Dr. McGraw's work will feel with me that they cannot be lightly passed over.

It has also been suggested by Moynihan and others that the gall-bladder should be removed in most cases of gall-stones, when it is certain that there is no obstruction of the common bile-duct.

Nearly all gall-stones are formed within the gall-bladder, and are secondary to pathological conditions chiefly affecting it. It seems to be reasonable to remove the source of the trouble with the object of preventing its recurrence, but true recurrence of gall-stones is an extraordinarily rare event. Drs. Mayo (*Ann. of Surg.*, vol. xlv. p. 210) in a review of 1500 operations upon the gall-bladder and bile passages found but one case of their own in which gall-stones re-formed in the gall-bladder. Stones which have been overlooked may be mistaken for recurrences. Schott (*Beit. Z. Klin. Chir.*, 1903, xxxix. S. 427) states that in only 5 per cent. of 180 cases from Czerny's clinic were there any biliary symptoms, and that in no case was a stone known to have formed, although the cases had been followed for about six years after the operation.

In many cases it is easier to remove the entire gall-bladder and the greater part of the cystic duct, than it is to extract the stones, which may be very numerous, and some of which may be overlooked in the cystic duct or elsewhere. In such cases the risk of infection is diminished, and the chance of recurrence is entirely abolished when the disease is limited to the gall-bladder.

The mortality of cholecystectomy is greater than that of cholecystostomy, even in skilled hands. Dr. Mayo writes: "Cholecystectomy has an increasing field of usefulness, but its increase of mortality, which, although slight, is for one reason or another fairly certain, prevents it from replacing cholecystostomy. At the same time, where the circumstances permit of easy removal of the gall-bladder and the disease is confined entirely to this organ, it is the operation we most commonly perform even in cases in which cholecystostomy would answer the purpose. But if the patient is very obese, and the gall-bladder has a broad attachment to the liver necessitating prolongation of the incision or increased manipulation, cholecystectomy is the more difficult and dangerous operation." For the great majority of operators cholecystectomy would be very much more difficult and dangerous than cholecystostomy.

When the gall-bladder is removed, the need for drainage of the biliary passages is generally abolished, and the recovery of the patient is thus accelerated. Should drainage be called for, it can be established by tying in a rubber tube passed into the remains of the cystic duct, but this is neither so easy nor so safe as draining the gall-bladder. It is rarely wise to excise the gall-bladder after the removal of stones from the common bile-duct, especially if cholangitis exists, for secondary operations are more often needed for common duct cases than any others. Moreover the gall-bladder may be useful later for drainage or cholecystenterostomy should there be future contraction and obstruction of the common bile-duct, and "it is also a safe guide to the deep ducts if future trouble should arise" (Mayo, *loc. cit.*).

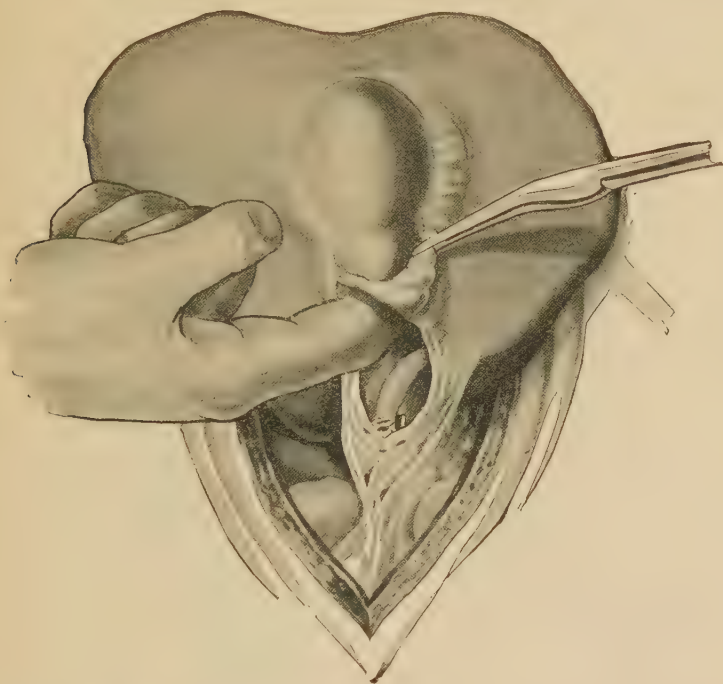
Another reason for removing the gall-bladder is that a thick-walled and contracted gall-bladder may be the seat of malignant disease which may only be discovered by microscopical examination after it has been removed. Dr. Sherrill (*Ann. of Surg.*, vol. xlv. p. 866) draws

attention to the frequency of this complication in late cases, and advocates earlier operation in order to avoid it.

There is little or no real evidence that carcinoma may form after the removal of the stones, but only that the disease may be overlooked in an early stage, while it is yet removable with hope of permanent immunity from recurrence. Mayo mentions one patient who has survived for over three years after an early cholecystectomy for this condition.

Operation.—The exploratory part of the operation has been already described at p. 545. When the gall-bladder has been carefully freed

FIG. 225.



Cholecystectomy. The cystic duct and artery are tied, the former as close as possible to its termination. The gall-bladder is being stripped up from the liver. The cut end of the cystic duct is closed by forceps. (Moynihan, *Abdominal Operations*.)

from adhesions (p. 548), and the surgeon has decided to excise it after due consideration, the cystic duct is exposed by incising the peritonæum over it.

To avoid any possibility of a mistake, the point of meeting of the cystic with the hepatic and common bile-ducts must be seen (*vide* Fig. 214, p. 547).

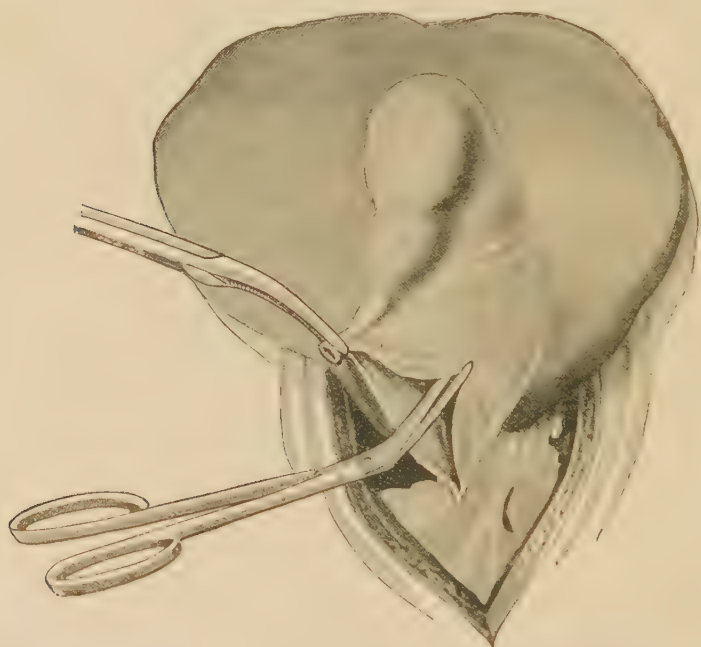
The cystic duct is tied with catgut, and divided about a quarter of an inch from its termination between the ligature and pressure-forceps, which prevent leakage from the gall-bladder and are useful for gentle retraction. The stump is cleansed and any mucous membrane protruding beyond the ligature is removed with sharp pointed scissors, and the stump is buried by sewing the peritonæum over it.

The cystic vessels are sought, and will be found usually a little above and to the left of the cystic duct, where they are ligatured and divided.

It is of considerable advantage to secure the pedicle before attempting to separate the viscus from the liver, so that blood oozing from the liver may not trickle back and obstruct the view; the bleeding is also lessened during the next steps.

The gall-bladder is now separated from the liver by blunt dissection from below upwards and forwards. For this purpose the index finger may be passed between the gall-bladder and the liver as recommended by Mr. Moynihan (*vide* Fig. 225).

FIG. 226.*



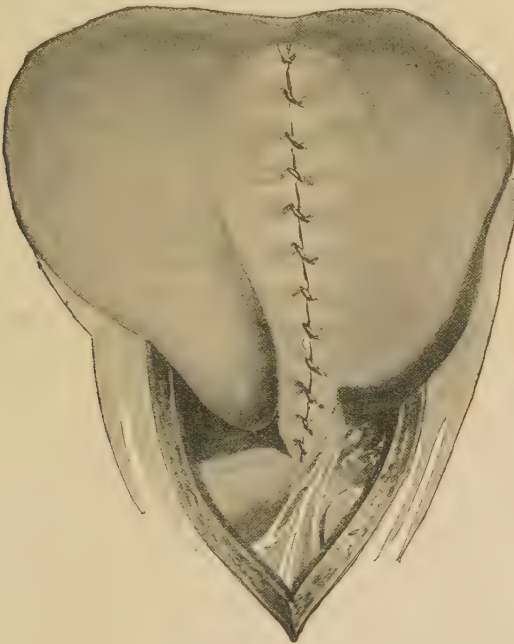
Cholecystectomy. The peritonæum is being divided between the gall-bladder, which is partly stripped, and the liver. (Moynihan, *Abdominal Operations*.)

The peritonæal covering is saved as far as possible until the separation is completed, and then it is so divided with scissors that the edges can be sewn together to cover the raw surface of the liver. This prevents adhesions and arrests hæmorrhage from the liver (*vide* Figs. 226, 227).

Occasionally when there are dense adhesions it may be easier to separate the gall-bladder from before backwards. In a normal case this will be simple, and all that is needful is to divide the reflection of peritonæum which passes from the liver over the gall-bladder, and then to shell out the latter from its fossa by gently tearing through the connective tissue and vessels which hold it in place, with the finger or a pair of curved scissors, these being used as a blunt dissector as well

as to cut with. In cases, on the other hand, where there is much matting of the parts, the omentum, duodenum, colon, pylorus may all require most careful detachment, bit by bit, before the gall-bladder is reached, lying far from the surface, puckered and shrunken. And when this is effected, repeated attacks of inflammation may have converted its immediate surroundings into a compartment of sclerosed fibro-fatty tissue out of which it has to be shelled like a kidney, the site of long-standing calculous pyelitis, from out of its thickened, matted capsule. Friability of the walls of the gall-bladder, these tearing away on the slightest traction, is another difficulty which may be very present with a deep-lying viscus. The gall-bladder having been separated as

FIG. 227.



Cholecystectomy. The operation completed by suture of the peritonæum over the bared surface of the liver. (Moynihan, *Abdominal Operations*.)

far back as the cystic duct, the first part of this is isolated, and its distal extremity tied with catgut.

Care must be taken not to include the hepatic, and still more the common duct, in cases where the depth of the wound and adhesions may make the relations of parts uncertain. Before severing the duct it will be well, if two ligatures have not been passed, to close its proximal end with clamp-forceps so that no bile escapes when it is divided.

If it is not possible to bury the stump it may be treated with a little pure carbolic acid. When it is not possible to cover the raw surface of the liver with peritonæum, the bleeding, chiefly of the nature of oozing, usually yields to well applied pressure, and the abdominal wound can be safely closed without drainage. The anterior

wall of the rectus sheath should be sutured in an overlapping manner to minimise the risk of ventral hernia (*vide* Fig. 228).

Treatment of Biliary Fistula.—This most troublesome affection, which is getting much less common, usually follows on cholecystostomies. It has already been alluded to, but owing to its importance and the difficulties which surround it, a few more words are required. If of any duration it depends, usually, upon one or two causes—a stone impacted in the common duct, or malignant disease of the head of the pancreas. The annoyance from the constant discharge, the difficulty of collecting this, the frequent change of dressings necessitated when

FIG. 228.



Dr. Noble's method of overlapping the aponeurosis to secure wide and firm union. (*Ann. of Surg.*)

the patient is about, the eczema and rawness around the wound, are very great. In the case of an impacted stone, if it cannot be felt and removed or dislodged by injections or by manipulations from the adherent gall-bladder, the abdomen should be freely opened by an incision to the inner side of the fistula, exposing the gall-bladder adherent to the parietes; the ducts are then examined and the stone localised in the common duct, and removed by incision. If the above course is really impracticable, cholecystenterostomy must be performed. In some cases choledoch-enterostomy has to be adopted (p. 563). When the only obstruction is in the cystic duct it is best to perform cholecystectomy if the patient wishes to get rid of the mucous fistula. Where it is found that malignant disease is the cause of the obstruction, if this be in an early stage (p. 559), the patient's power of repair good, and the blood not yet seriously altered, cholecystenterostomy should be considered.

The Mortality of operations upon the Gall-bladder and Bile-ducts.—This has been greatly diminished during recent years, especially in the hands of surgeons with a large experience of these operations. It must not be forgotten, however, that the average operator does not get nearly such good results as those

mentioned below. Dr. Mayo (*loc. supra cit.*) and his brother had 66 deaths in 1500 operations upon these organs. In the last 500 cases the death rate was only 3·2 per cent. These statistics include all operations for acute perforations, with septic peritonitis and malignant disease; and also all deaths occurring in the hospital without regard to the length of time after the operation. "There were 845 cholecystostomies with a mortality of 2·13 per cent." In the last 272, the death-rate was only 1·47. There were 319 cholecystectomies, with a death rate of 3·13 per cent., which was reduced to 1·62 per cent. in the cases included in the last series of 500 operations referred to above.

There were 207 operations upon the common duct. Dr. Mayo divides them into four groups:—

Group 1. In one hundred and five, gall-stones were present in the

common duct, but without any serious symptoms of infection or complete obstruction. The mortality was 29 per cent.

Group 2. There were 61 cases, in which infection of the common and hepatic ducts had occurred, with "remittent fever" and deep jaundice (infective cholangitis). Ten deaths occurred giving a mortality of 16 per cent., and in seven cases hepatic duct stones had formed and gave rise to later troubles.

The recurrence of stones also occurred in at least three cases in which there was enlargement of the head of the pancreas.

Group 3. There were 29 cases with complete obstruction of the common bile duct, with 10 deaths (34 per cent.). The general condition of these patients was very bad, and some of them had œdema of the feet, with bile-stained fluid in the peritonæal cavity, nephritis and more or less cholæmia. Dr. Mayo believes that "it is often wise to wait for a period of remission before operation" in cases of acute complete obstruction.

Group 4. There were 12 operations for malignant disease with four deaths, $33\frac{1}{3}$ per cent.

CHAPTER X.

OPERATIONS ON THE PANCREAS.

The Treatment of Injuries, Pancreatitis, Pancreatic Calculi, Pancreatic Cysts, and New Growths.

For a knowledge of these diseases we are largely indebted to Senn, Fitz, Opie, Mikulicz,* and Mayo Robson.† The last two especially have done brilliant work in establishing the diagnosis and treatment of diseases of the pancreas upon a sound basis. Placed deeply in the abdomen, and surrounded by structures of great importance, this organ was long considered to be beyond the reach of surgery, but more accurate knowledge of the pathology of the pancreas, and of the special surgical principles which must be observed to attain success in this branch of surgery, has already done much to change our views, and recent results show that the future is full of promise.

We owe much to Professor Mikulicz for pointing out the best ways of dealing with the peculiar dangers and difficulties which attend operations upon the pancreas.

Difficulties and Dangers and the Methods of meeting them.

(a) *Diagnosis*.—The position of the pancreas makes it very difficult for us to feel and recognise any enlargement of it, unless the patient is very thin or the abdominal wall relaxed under the influence of an anæsthetic.

The function of the organ is not influenced very much until the disease is too advanced or extensive for successful surgical treatment to be undertaken. Systematic examinations of the urine (Cambridge, *Lancet*, 1904, vol. i. p. 782) and of the fæces will very probably provide us with earlier indications of functional changes, and will enable us to arrive at a diagnosis or to explore earlier than heretofore. Until recently wounds and contusions of the pancreas were more serious than those of any other abdominal organ. The chief reasons for the high mortality were (a) the low condition of the patient at the time of the operation, owing to delay in diagnosis; (b) hæmorrhage and the difficulty of arresting it; (c) escape of pancreatic secretion into the peritonæum; (d) concomitant injuries.

(b) *Hæmorrhage*.—The pancreas is friable, and its vessels thin-walled and very numerous, so that it is very difficult to stop bleeding from it. It is impossible to catch the individual blood-vessels with artery forceps in the usual way, and ligatures often do not hold, but

* *Ann. of Surg.*, 1903, vol. xxxviii. p. 1.

† Hunterian Lectures, *Lancet*, 1904, vol. i. pp. 773, 845, and 911.

tear through the delicate tissues and blood-vessels. It is best to suture any wounds or lacerations with stout catgut, which must take a good bite, and must not pierce the ducts or be drawn too tightly. Ligaturing *en masse* will also stop the bleeding, but gangrene of the isolated tissues may arise and be followed by secondary hæmorrhage. Gauze packing is usually successful. Hæmorrhage is not only serious in itself, but the blood also forms with the pancreatic juice an excellent culture material for bacteria.

(c) *Escape of Pancreatic Juice* and exudation from the injured and inflamed gland into the peritonæal cavity is a very serious catastrophe, which almost inevitably leads to peritonitis, whether the contaminating fluid is originally infective or not. The pancreas is very easily infected from the common bile-duct, which often contains infective material, owing to the obstruction at the ampulla of Vater, which is frequently the cause of the pancreatic disease. Every effort must therefore be made to prevent any leakage of the pancreatic exudate into the peritonæal cavity. This can be done by establishing free anterior drainage, or in some cases by suturing the peritonæum over the pancreas, and establishing posterior drainage. It is dangerous to let the fluid escape and burrow in the retro-peritonæal tissues, for infective cellulitis may result from this. Moreover, the pancreatic juice dissolves the clots in and around the severed blood-vessels, and restarts hæmorrhage. It is essential, therefore, to drain away the fluids from the injured or diseased pancreas, and failure to do this has almost always led to disaster.

The danger of wounding the pancreas during operations is shown by the fact that out of 30 resections of the stomach in which the pancreas was wounded either accidentally or intentionally the mortality was 70 per cent., whereas the death-rate of 91 resections without any injury of the pancreas was 27·5 per cent. The difference could not be entirely or even chiefly due to the more extensive or later disease, for the deaths mostly occurred not from shock, but from peritonitis, which was doubtless due to the escape of pancreatic secretions into the peritonæum (Mikulicz).

Various Methods of approaching the Pancreas.—There are several ways of reaching this deeply placed organ, and they may be conveniently divided into anterior and posterior operations.

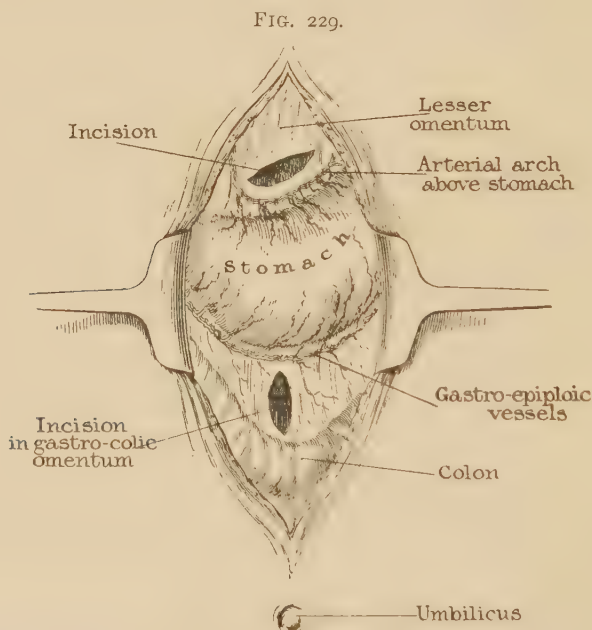
The anterior route allows a far more thorough exploration, but the posterior provides the best drainage in some cases, and carries less risk of peritonæal infection from escaping pancreatic secretions.

The Anterior Route.—The abdomen is opened by making an incision between the umbilicus and the ensiform cartilage, a little to one or other side of the middle line (*vide* Fig. 211, p. 531). The fibres of the rectus may be either drawn out or separated. Better drainage is provided by separating the fibres, and this also gives less risk of infection of the abdominal wall in infective cases. In rare cases, where drainage is likely to be quite unnecessary, a valvular incision may be made by displacing the rectus (*vide* p. 507). The abdomen having been opened, there are several ways of getting at the pancreas. In some cases the surgeon has no choice, for a swelling, such as a cyst or abscess, has already approached the surface either below or above the stomach, and the surgeon should then abide by nature's

decision. When little or no swelling exists much may depend upon the mobility and position of the stomach.

(a) *Through the gastro-colic ligament* (vide Fig. 229). This should be picked up and incised below the greater curvature, and the vascular arch that lies beneath it. A vertical incision should be made to avoid the omental blood-vessels, and this should be enlarged to the required extent by tearing. The lesser sac having been opened, the anterior surface of the pancreas can be examined after displacing the stomach upwards.

(b) *Through the gastro-hepatic omentum* a transverse incision is made through this membrane where it is thin above the vascular arch,



The pancreas is best approached either through the gastro-colic ligament or through the gastro-hepatic omentum, according to the relation of the stomach to the pancreas and to the position of any bulging.

and to the left of its thick right border, which includes the portal vein, hepatic artery, and common bile-duct. When the stomach is drawn downward, the pancreas can be exposed with ease.

(c) *Through the transverse meso-colon* after displacing the colon upwards as in gastro-jejunostomy. This method does not give such a good view, nor so direct an approach, and, lastly, it is unfortunately placed for establishing anterior drainage, for any leaking fluid will at once gravitate amongst the coils of small intestine. Dr. Porter, however, used this route in his successful case of acute pancreatitis; he used a transverse incision within the arterial arch which supplies the transverse colon.

(d) *By displacing the duodenum* after Kocher's method of incising the parietal peritonæum to the right of the descending part of this

intestine. This method only gives access to a part of the head, and its adoption is difficult and may be attended with profuse hæmorrhage. Moreover, drainage is difficult from this situation.

(e) *Through the duodenum*.—The pancreatic duct towards its termination and the ampulla of Vater may be reached through a longitudinal incision in the anterior wall of the duodenum (*vide* Fig. 214, p. 547).

(f) *Through the stomach*.—This method is only mentioned to be condemned. Hagen used it successfully in one case, that of a very adherent pancreatic cyst in a boy. It was found to be impossible to bring the cyst to the abdominal incision, and as it lay directly behind the stomach, the anterior and posterior walls of the latter were incised, and the cyst emptied. A part of the costal margin was then resected, and the cyst wall, now more movable, was brought to the parietal peritonæum after displacing the sutured stomach. In such a case it would be far better to first aspirate the cyst below or above the stomach, and then to bring the lax cyst wall to the surface, or, failing this, to fix a tube in it with a purse-string suture. It might also be approached from the left loin.

(g) *Post-approach*.—Either an oblique or a vertical incision may be made in the left loin, or in some cases of disease of the head of the pancreas in the right loin. The vertical incision should be parallel and a little external to the outer border of the erector spinæ, as advised by Mr. Cathcart. An oblique incision closely resembling the one employed in nephrolithotomy may be used.

INJURIES.

The pancreas is not often injured, because of its deep and protected position, but when it is damaged either from contusion or penetration, other organs are very frequently affected at the same time.

When the abdomen is explored under these circumstances, pancreatic lesions are very apt to be overlooked, with fatal consequences. It is important, therefore, to examine this organ before completing all explorations for injuries of the upper abdomen.

Apart from wounds, it will be a rare event for a correct diagnosis to be arrived at before the abdomen is opened for signs of internal hæmorrhage, abdominal tenderness and rigidity, indicating peritonæal irritation of uncertain cause, but demanding immediate attention. In a few cases a swelling may appear in the epigastrium, and in one case that I saw there was glycosuria.

Even when an injury of the pancreas is suspected the abdomen should be explored through an incision near the middle line, so that the other viscera may be examined also. Blood may ooze from the lesser sac of peritonæum, or areas of fat necrosis may draw the attention of the surgeon to the pancreas, which he may then find to be enlarged from hæmorrhage.

The gland may be approached either through the gastro-colic ligament, small omentum, or transverse mesocolon.

Hæmorrhage must be arrested by sutures, ligatures, or gauze packing, and free drainage must be established either anteriorly, posteriorly, or both ways. When the peritonæum can be sewn over the damaged organ this should be done, but this does not abolish the need of drainage, at least through the loin.

In cases of wounds from behind, it is only necessary to explore the abdomen when signs and symptoms of penetration of the peritonæum manifest themselves; but the patient should be carefully watched, so that abdominal section can be undertaken immediately if any indications arise.

Gunshot wounds are generally penetrating, and inflict injuries upon neighbouring organs, such as the stomach, colon, or small intestine. In any case drainage is essential.

Mikulicz collected 45 cases of injury of the pancreas, 21 penetrating and 24 subcutaneous lesions. Of the former 12 were gunshot wounds, of which five were treated by operation, with three recoveries; and seven were not operated upon, all of these died.

Out of nine stab wounds only two penetrated the peritonæum; no drainage was employed in one of these, who died; the other recovered notwithstanding multiple intestinal perforations.

All of the seven with retro-peritonæal stab wounds recovered, but in several of these the gland had prolapsed into the wound without being seriously damaged.

In some cases the tail may be resected after ligation or suture of the gland near the line of section to prevent hæmorrhage.

Out of 24 subcutaneous injuries no operation was undertaken in 13; all of these patients died, but as death was the means of the discovery of the lesions, it is quite possible and even probable that some patients recover from slight subcutaneous injuries. Of 11 treated by operation seven recovered.

It is significant that out of 12 operations for various injuries drainage was employed in eight, with six recoveries, and that the four cases in which drainage was not considered necessary ended fatally.

Dr. Randall (*Lancet*, 1905, vol. i. p. 291) successfully operated on a man, æt. 48, who had been injured in the epigastrium by the pole of a van, which jammed him against a stationary van. The operation was undertaken six hours after the injury, on account of gravity of the collapse, the site of the injury, and dulness in the right flank. The abdomen was opened above the umbilicus, and much clotted and fluid blood was removed. A large tear was found in the small omentum, and another in the posterior wall of the lesser sac, through which a laceration two inches long was discovered in the body of the pancreas, and the aorta was felt in the floor of the wound, which was sutured with four silk stitches. There was not much trouble from hæmorrhage. Drainage was established, and the peritoneal cavity cleansed and irrigated. The man ultimately recovered completely, although he had troublesome mental symptoms for a time and developed a ventral hernia at the site of drainage.

ACUTE PANCREATITIS; ACUTE HÆMORRHAGIC PANCREATITIS.

This is an acute inflammation of the pancreas, usually associated with and sometimes arising from profuse interstitial hæmorrhage, and either terminating fatally in a few days or subsiding into subacute or chronic pancreatitis. In some cases suppuration or even extensive gangrene of the pancreas may occur.

The first accurate account of this rare disease was given by Fitz (*New York Med. Record*, 1889). Since then a number of cases have been recorded by various observers.

The chief symptoms, as summarised by Fitz, are—"sudden, severe,

often intense epigastric pain, without obvious cause, in most cases followed by nausea, vomiting, sensitiveness, and tympanitic swelling of the epigastrium. There is prostration, often extreme, frequent collapse, low fever, and a feeble pulse. Obstinate constipation for several days is the rule, but diarrhœa sometimes occurs. If the case does not end fatally in the course of a few days, recovery is possible, or a recurrence of the symptoms in a milder form takes place, and the characteristics of a subacute peritonitis are developed."

Cyanosis of the face and a general lividity is also a striking sign in some cases; this was evident in several patients that I have seen.

Very few of the cases have been correctly diagnosed, the majority, as will be readily understood by consideration of the above-mentioned symptoms, having been thought to be either acute peritonitis (especially that due to perforation of a gastric ulcer) or acute intestinal obstruction, usually the latter. Recently a correct diagnosis has more frequently been made.

In a few instances the presence of an epigastric tumour has materially aided the diagnosis; such cases have been recorded by Thayer (*Amer. Journ. of Med. Sci.*, vol. cx.), Pitt (*Clin. Soc. Trans.*, vol. xxxii.), and others. In Thayer's case, abdominal section revealed the presence of an abscess in connection with the pancreas, drainage of which resulted in recovery. In Dr. Pitt's case, the tumour was chiefly due to blood effusion in and around the pancreas.

Treatment.—The uncertainty of the diagnosis, or the fact that acute pancreatitis was unsuspected, has led, in the majority of cases, to the performance of an exploratory laparotomy. Should such an operation be performed on a patient supposed to be suffering from either acute intestinal obstruction or acute peritonitis with a negative result, the possibility of acute pancreatitis must be considered. The following points will be found useful under such circumstances:

(1) *Fat necrosis* may be present. This occurs in the form of small patches, circular or oval in shape, and of an opaque white or yellow appearance, scattered about the fat over the pancreas, the omentum, and the mesentery. If, on careful inspection with a good light, evidence of fat necrosis is found, it may be inferred that some serious lesion of the pancreas is present. Absence of fat necrosis, on the other hand, does not exclude the possibility of acute pancreatitis.

(2) *Blood-stained fluid* is found within the abdominal cavity.

(3) *Swelling of the pancreas on palpation.*—This may be due to inflammatory exudation, blood effusions, or a collection of pus. In order to further examine the pancreas, it must be approached either through the small or great omentum, whichever is found to be the more convenient. It is then found to be greatly swollen, soft, and of a purplish colour.

If a diagnosis of acute pancreatitis is made either before or after exploratory laparotomy, the further treatment will depend upon the particular condition of the pancreas that is found to be present.

The swollen gland is incised with due regard to the large blood-vessels and the pancreatic duct. Hæmorrhage is arrested by means of tampons of gauze, and free drainage is established either anteriorly or posteriorly. Mr. Mayo Robson favours posterior drainage through the left loin. The disadvantages of this are that (1) another incision will have

to be made, which may lead to injury of the splenic or renal vessels if done hurriedly, as may be necessary in these patients. (2) Posterior drainage does not certainly prevent leakage from the anterior surface of the gland into the peritonæal cavity; on the other hand, it does prevent retro-peritonæal extravasation. A large rubber tube containing a wick of gauze, and surrounded with layers of the same, may be used for drainage.

The peritonæum should be mopped quite dry of the sanious fluid within it.

Mikulicz advocates irrigation with normal saline solution.

Mr. Mayo Robson recommends that the gall-bladder and bile-ducts be examined, and that if a calculus be discovered at the ampulla it should be removed if the patient's condition allow, or if not, that a cholecystotomy be performed, with the object of providing a vent for the retained and infective contents of the biliary and pancreatic ducts.

Opie and Mayo Robson have shown that regurgitation of septic bile into the pancreas is at least a common cause of acute pancreatitis. But the condition of the patient is rarely such as to allow any radical operation, and it cannot be said that even cholecystotomy is necessary for recovery, although it may contribute towards it, if done without unduly prolonging the operation.

Owing to the extremely serious condition that the patient is usually in, every possible precaution must be taken to avoid shock, and the operation itself must be performed as rapidly as possible.

For a long time acute pancreatitis was regarded as an inevitably fatal disease, so that when it was discovered during the exploration no attempt was made to deal with the pancreas directly.

In four cases, however, peritonæal drainage alone was attended with success.

Dr. Muspratt, an old Guy's man, was the first to treat this disease rationally on Dec. 2, 1902, and his surgical instinct and courage were rewarded by the recovery of the patient (Dr. Muspratt and Dr. Ramsay, *Brit. Med. Journ.*, 1904, vol. i. p. 304).

The patient was a woman, 40 years of age, who, after years of abdominal suffering, was suddenly seized with severe pain in the abdomen, attended by collapse and persistent vomiting. Laparotomy was performed within twenty-four hours, and a swollen, tense, and purple pancreas discovered. A free incision was made into its head, and free hæmorrhage followed, but this was checked after some trouble, a gauze drain was inserted, and the patient rapidly recovered.

Dr. Porter, of Boston, soon afterwards operated successfully upon the same lines, on Feb. 17, 1903 (Mikulicz, *loc. supra cit.*). The patient was a man, 56 years of age, who was under treatment in October, 1902, for dull pain in the right hypochondrium, from which he had suffered for several years. He also complained of chronic constipation. A year before admission he had sharp pain in the epigastrium and right iliac fossa. He had never had jaundice, vomiting, or rigors. From Nov. 5, 1902, to Feb. 17, 1903, he had several attacks of severe pain in the right hypochondrium and epigastrium, and in January, 1903, slight jaundice appeared, and gall-stones were diagnosed. On Feb. 15 sudden, severe epigastric pain developed, and extended to the right iliac fossa. The pain continued in spite of temporary relief with morphia, and later it became general all over the abdomen, and it was accompanied with vomiting and constipation which was not complete. The man was emaciated, very restless from much pain and distress; the vomit was neither fæcal, nor did it contain blood. Abdominal distension and rigidity was moderate, and there was no visible peristalsis. Shifting dulness was noticed. The temperature was 100°, the pulse 100 and weak, the respiration 30 per minute. A diagnosis of intestinal

obstruction due to a band was made: the band being considered to be secondary to gall-bladder or appendicular disease. An incision was made from 3 inches below the ensiform cartilage to within 2 inches of the pubis. A large amount of brownish red fluid escaped; this proved to be sterile.* No obstruction could be discovered, the appendix was congested and was removed, the fat in its mesentery was necrosed. The gall-bladder was full of bile, the pancreas was twice the normal size, hard and tense. The abdomen was irrigated and the wound closed. A second incision was now made parallel to the left costal margin, which was retracted, and the stomach and small intestines were packed away with gauze, and the pancreas approached through the transverse meso-colon; it was very large, tense, œdematous, and deep purple in colour. No stones could be felt in the pancreatic duct. The pancreas was freely incised along its anterior surface, and drainage was established. The patient improved rapidly. In April it was considered to be necessary to re-operate on account of recurrence of pain. A small cavity was found in the pancreas containing sterile debris. The gall-bladder was stitched to the wound, but not opened. The duodenum was turned forwards for examination of the head and duct of the pancreas. Pneumonia followed, but the patient recovered in spite of this and gained ten pounds in weight.

Mikulicz analysed the records of 75 cases of operation for acute pancreatitis, of 37 of these in which the pancreas itself was involved in the operative interference, 25 recovered. Of 41 where the pancreas was not tackled, 4 recovered with peritonæal drainage, and after cæcostomy for paralytic distension in one case (Henle).

Mayo Robson (*loc. supra cit.*) has operated upon 6 cases with two recoveries. He states that after 59 operations undertaken in the acute stage, 23 recoveries took place.

If all the cases were published the results would not be so favourable, but every recovery means a life saved, for few, if any, patients ever recover spontaneously from acute pancreatitis.

It has been suggested that the operation should be deferred until the subacute stage of the disease, but this is inadvisable, for the large majority of the patients, if untreated, die in the acute stage, and only the milder cases ever reach the more favourable subacute stage of suppuration.

SUBACUTE PANCREATITIS.

Here the inflammation is less acute from its commencement, and the patient survives long enough for suppuration or gangrene to occur. The abscess may burst into the stomach, colon, duodenum, or peritonæum, or it may reach or bulge forwards into the epigastrium or umbilical region, or backwards into the loin generally on the left side.

Spontaneous recovery may occasionally occur from rupture into the alimentary canal, or upon the surface, but if the condition is not treated surgically, death usually occurs from septicæmia, sub-diaphragmatic abscess, wasting, or pulmonary complications.

Operation.—The abdomen is opened by separating the fibres of the rectus abdominis, above the umbilicus, and to either side of the middle line according to the position of the swelling which may usually be discovered, especially when the patient is anæsthetised. The abscess may bulge forwards either below or above the stomach, and therefore it may be approached through either the gastro-colic ligament or the

* Hlava and others had previously shown that the sanious peritonæal fluid and also the exudation within the pancreas are sterile in at least some cases early in their course.

small omentum (Fig. 229), the most direct route being selected in each case, after carefully protecting the peritonæum by gauze packing. Drainage may be established by means of a rubber tube containing a wick and surrounded with a layer or two of gauze. The wound is then partly closed.

Mr. Mayo Robson (*Brit. Med. Journ.*, May 11, 1901) recommends a vertical posterior incision in the left costo-vertebral angle for this purpose. Such an incision would certainly be more favourably placed for the purposes of drainage; great care, however, would have to be exercised in carrying out this plan in view of the important structures which might be injured. This plan is especially suitable for large collections.

If the surgeon has not opened the abscess in front, he can then dispense with anterior drainage and close the wound completely so as to avoid the risk of ventral hernia.

In the majority of cases anterior drainage alone will be both necessary and sufficient, and there is little risk of contaminating the peritonæum if care be taken to pack around before opening the abscess.

Either immediately or later, characteristic grey or greyish black sloughs of the pancreas may come away, as in a case that I saw under the care of my colleague, Mr. Dunn, in 1898.

This patient, a middle aged stout woman, had suffered such agonising pain in the epigastrium and right hypochondrium, that she had acquired the morphia habit. In the last attack a vague swelling appeared above the umbilicus and to right of the middle line, vomiting became very troublesome, and constipation almost complete. The abscess was opened through the right rectus muscle and gastro-colic ligament. This gave immediate relief, and the patient gradually made a complete recovery.

In one case Mr. Mayo Robson performed a gastro-jejunostomy successfully after an abscess had burst into the stomach and continued to discharge its foul contents into the latter.

Mr. Mayo Robson has recorded 7 operations with 5 recoveries, and has collected 7 others with 4 recoveries. Two of Mr. Robson's 5 patients who recovered from the operation died later; one after a few weeks from pulmonary complications, and the other from exhaustion and wasting after a few months.

CHRONIC PANCREATITIS.

Riedel first pointed out the relation of this condition to cholilithiasis, but to Mr. Mayo Robson belongs the credit of defining and drawing the attention of the profession to this important subject (*loc. supra cit.*). In the great majority of cases, chronic pancreatitis is secondary to impaction of a calculus within the ampulla of Vater or in the lower part of the common bile-duct or the pancreatic duct. But when an operation is undertaken the calculus may have already sloughed out or passed on into the duodenum or may not be discovered.

It is due essentially to infection ascending along the pancreatic duct, and it has followed typhoid fever as in a case recorded by Mr. Moynihan.

The result is a chronic interstitial and parenchymatous inflammation

which usually and chiefly concerns the head of the pancreas, which becomes enlarged and hard, so that it closely resembles malignant disease, for which it has been very frequently mistaken during exploratory operations for jaundice and other signs of obstruction of the common bile-duct; under these circumstances cholecystostomy has been performed and the patient has recovered, much to the surprise of all concerned.

If left too long untreated, the patient may die of obstructive jaundice or rapid emaciation. Long continued obstruction to the flow of pancreatic juice may lead to such an amount of destruction of the pancreatic tissue as to lead to diabetes, and similarly the liver may become cirrhotic from obstruction to the biliary flow. As far as possible the diagnosis between carcinoma and chronic pancreatitis must be made before an operation is undertaken, for operative interference does no good in cases of carcinoma of the head of the pancreas, and even an exploration may prove fatal. A careful consideration of the clinical history, especially the history of cholelithiasis, and a careful examination of the urine, will often lead to a correct conclusion.

Mr. Mayo Robson believes that Dr. Cammidge's reaction is of great value in these cases, but others are not so sanguine (*Lancet*, 1906, vol. i. p. 756).

Treatment.—A thorough exploration should be undertaken through the right rectus, and a decision made between carcinoma and chronic pancreatitis from palpation of the pancreas, and the presence or absence of any calculous obstruction of the bile or pancreatic duct, especial attention being paid to the ampullary region.

Any calculus that may be discovered is removed (*vide* p. 558), and this may be enough in some cases, but if there be much sclerosis of the pancreas, or if no calculus be discovered, free drainage of the infective contents of the pancreatic and bile-ducts must be established by performing cholecystostomy, or cholecystenterostomy, or if the cystic duct be obstructed the common bile-duct must be drained (*vide* pp. 555, 556).

Cholecystostomy is easier, safer, and better than cholecystenterostomy; for infection of the ducts may take place through the fistula into the duodenum, but the danger of this has been exaggerated, as shown by the researches of Radziewski (Mikulicz, *loc. cit.*).

Mayo Robson (*loc. supra cit.*) records 51 cases with two deaths from operation, a mortality of 3·9 per cent. Out of 62 published cases eight died, giving a death-rate of 12·9 per cent.

In 27 cases of calculous obstruction, recorded by the same surgeon, choledochotomy was performed in 19, cholecystostomy in five, and cholecystenterostomy in three.

Some time afterwards all these patients were well, except one who had died from bronchitis, one who was suffering from cirrhosis of the liver, and one who had glycosuria 8½ years after the operation.

Out of 24 cases in which no calculus was found cholecystostomy was performed in 12, cholecystenterostomy in nine, and in two adhesions were separated only. Twenty-two of these patients recovered, and some time afterwards replies were received from 18 of them; all of these were well except one, who had glycosuria.

It need hardly be pointed out that these results, obtained by a surgeon of unusual experience of this branch of surgery, are far more favourable than the average for all surgeons who may be called upon to undertake these operations, but they serve to show what can be done by careful work based upon a sound knowledge of the pathology of chronic pancreatitis.

PANCREATIC CALCULI.

Mr. Pearce Gould removed a pancreatic calculus in March, 1896, but the patient died twelve days later. Mr. Moynihan was the first to correctly diagnose and successfully remove a stone from the duct of Wirsung in May, 1902 (*Lancet*, 1902, vol. ii. p. 355).

The patient "was a lady, aged 57, who had suffered for several months from symptoms which may be briefly described as follows:—There was steady loss of health, gradual wasting, irregular pigmentation of the skin, in patches of the colour of café-au-lait (very closely resembling the pigmentation of molluscum fibrosum), persisting attacks of epigastric pain, and uneasiness of the type of hepatic colic, though less severe, and unattended until very late in the history by jaundice, which was then always trivial, though unmistakable, and pain passing through from the front of the abdomen to the middle of the back. There was no rigor or any complaint of sensation of heat or cold. The stools were occasionally frothy and greasy. On examination under chloroform some indefinite swelling could be felt above the umbilicus and a little to both sides of the median line though chiefly to the right."

Mr. Moynihan diagnosed chronic pancreatitis, due probably to a pancreatic calculus, which had produced the epigastric colic during its transit along the duct of Wirsung, and had later caused some inflammatory obstruction of the common bile-duct. The abdomen was opened by separating the fibres of the right rectus muscle, and the diagnosis was confirmed. "The head of the pancreas was very much enlarged and hard, the body was less so, but still larger and denser than the normal." A small lump was felt between the duodenum and the pancreas, and upon opening the duodenum and the ampulla of Vater a small soft stone was discovered at the end of the duct of Wirsung, whence it was removed with a scoop. The patient made a complete recovery and was quite well in March, 1905.

Mr. Mayo Robson, Dalziel, and L. W. Allen have also removed stones from the pancreas.

Mayo Robson (*Lancet*, 1904, vol. ii. p. 113) successfully removed four pancreatic stones, two from the ampulla after opening the duodenum, and one each from the ducts of Santorini and Wirsung. The ducts and the pancreas were sutured and no drainage was employed.

Pancreo-Lithotomy.—Pancreatic calculi may be removed (a) from the duodenum, and through the ampulla of Vater by a slight modification of the operation of duodeno-choledochotomy (*vide* p. 558).

(b) If this is impracticable, the pancreas may be approached through the gastro-hepatic or gastro-colic omentum, and an incision made directly over the stone and parallel to the duct. When the stone has been removed both the duct and the pancreas should be carefully sutured, but drainage should be established from the line of suture to avoid any possible leakage and peritonæal contamination. A sandbag under the back is of great value in bringing the duodenum and the pancreas much nearer the surface.

PANCREATIC CYSTS AND PSEUDO-CYSTS.

Mr. Moynihan (*Abdominal Operations*, p. 612) gives the following classification of these cysts:—

- (1) Retention cysts.
- (2) Proliferation cyst $\left\{ \begin{array}{l} \text{Cystic adenoma.} \\ \text{Cystic carcinoma.} \end{array} \right.$
- (3) Hydatid cysts.
- (4) Congenital cystic disease.
- (5) Hæmorrhagic cysts.
- (6) Pseudo-cysts.

Effusions into the lesser sac of the peritonæum were for long mistaken for pancreatic cysts, partly because the fluid withdrawn from these pseudo-cysts often contained pancreatic secretion, and partly because the pancreas formed a part of the wall of the cyst.

Mr. Jordan Lloyd first drew attention to the true nature of the so-called cysts which followed injuries of the upper part of the abdomen (*Brit. Med. Journ.*, 1892, vol. ii. p. 1085). They generally take the characteristic shape of the lesser peritonæal cavity, and if the pancreas has been injured, their fluid contents may have “the property of converting starch into sugar.”

Mr. McPhedran (*Brit. Med. Journ.*, 1897, vol. i. p. 1400) records an interesting example of this condition, and later a true pancreatic cyst developed in this patient, and was probably due to obstruction of the pancreatic duct.

Mr. Kellock (*Clin. Soc. Trans.*, vol. xxxix. p. 63) describes another instance of “traumatic pancreatic pseudo-cyst” and refers to seven more. In four out of these eight cases the injury was a kick from a horse. In Mr. Kellock’s case the collection of fluid became evident after a month. The patient suffered much from pain, vomiting, dyspnoea, and became thin, pale, and weak. The temperature was about 100° F., and the pulse became 120, the respirations 36. Dulness extended from the left loin to the middle line and downwards as far as the umbilicus, and a thrill could be obtained over it. An exploratory puncture through the ninth interspace in the scapular line was made and some turbid fluid was withdrawn. A portion of the ninth rib was resected in the axillary line, and the lesser peritonæal sac opened through the diaphragm, and 88 ounces of fluid were collected, and found later to contain an active diastatic and also a peptonising ferment, acting in an alkaline medium. No micro-organisms were present. “Considerable difficulty was experienced in keeping the cavity drained,” although a rubber tube had been sewn in, and a few days later the wound had to be explored, and 70 ounces of fluid were liberated, and another opening was made further back below the ribs. Large drainage tubes were inserted in the openings, “but seven days later the fluid had again reaccumulated”; 100 ounces were withdrawn by means of a Boudin’s glass tube. Ultimately a gum-elastic catheter was inserted and drainage established into a bottle at the side of the bed, and an average of 28 ounces of fluid was collected every day. After about four weeks from the operation the discharge ceased and the patient made a rapid and complete recovery.

Diagnosis of Pancreatic Cysts.—Attention to the following points will generally lead to a correct conclusion. A rounded, elastic, deeply fixed swelling, which may date to an accident, appears, usually in an adult, in the epigastric and left hypochondriac regions, is generally accompanied (especially when its increase is rapid) by “cœliac neuralgia”—i.e., pains probably arising in the solar plexus—often colicky, or even agonising, and leading to collapse. Dyspepsia,

marasmus, and mental depression are often present to a marked degree. The position of the cyst, behind the stomach and transverse colon, is important. This relationship may be demonstrated by percussion with or without inflation of the stomach and colon with gas, and also with the aid of a rubber tube containing an emulsion of bismuth, and the shadow thrown by this upon the X-ray screen (Dalton). Both side to side and front to back shadows should be taken.

The resonance of the stomach is often above the cyst, and that of the colon below it, the centre or most prominent part being dull.

The cyst may present and be dull above the stomach, or below the transverse colon towards the left loin. I have known such a cyst mistaken for hydronephrosis. The segregator will help to distinguish the two conditions, for equal amounts of urine should issue from the two ureters if the cyst is pancreatic, whereas the amount and the characters of the separated urines will be different in hydronephrosis, even if any comes from the left ureter. The urine may contain sugar with pancreatic cyst. The fæces may contain an excess of fat or muscle fibre in a few cases.

Treatment.—Dr. Senn showed that the wisest course was incision of the cyst by abdominal section. The results of attempting to extirpate the cyst have been so unsuccessful as to entirely justify his condemnation of this course except in quite exceptional cases. Aspiration is not to be recommended because it is never successful, and is not without danger. It is not even advisable to employ it for diagnostic purposes (*vide* foot-note, p. 583) or for the temporary relief of tension.

(1) **Evacuation and drainage.**—The cyst is approached as already described at p. 577. Generally it is best to incise the gastro-colic ligament.

The following case,* in which I operated at the request of Dr. Newton Pitt, is a good instance of a pancreatic cyst treated by laparotomy, incision, and drainage:—

I received the following history when asked to see the case, August 21, 1889: The patient was 21. He had received a kick in the abdomen three years before which had confined him to bed for three weeks. Ever since he had been liable to severe attacks of epigastric pain. He had been markedly jaundiced, was emaciated, and suffered a good deal from nausea and depression. The swelling in the epigastric region was convex and uniform, and reached from below the tip of the ensiform cartilage to just above the umbilicus, and laterally to near the ends of the eleventh ribs. The tumour gave the impression of being attached to some deep-seated structure. There was transmitted impulse synchronous with the pulse, but not expansile. As the swelling had refilled after two previous tapplings,† and, as the swelling and the patient's distress were steadily

* My colleague and I reported this case fully (*Trans. Med.-Chir. Soc.*, vol. lxxiv. p. 455). References are given to 30 cases which will be found summarised there by Dr. Pitt. References are also made to 13 cases by Mr. Cathcart in his instructive paper (*Edin. Med. Journ.*, July 1890).

† The fluid was alkaline, sage-green, sp. gr. 1013, albuminous, and, under the microscope, showing innumerable collections of globular masses of tyrosin crystals. No leucin could be detected. The fluid in these cysts varies a good deal—sometimes colourless and serous, at others it is red and viscid. It will be seen from the account that follows that on each occasion the aspirating needle must have transfixed the stomach. The same thing, with like harmlessness, happened in one of Kurewsky's two cases (*Deut. Med*

increasing, laparotomy was performed, August 22, with strict antiseptic precautions. An incision, three inches long, was made over the most prominent part of the cyst, an inch and a half to the left of the middle line, extending to within an inch of the umbilicus. The parietal peritonæum having been stitched to the margins of the wound, the lower edge of the liver could be seen moving with respiration in the upper angle, while the rest of the incision was occupied by a smooth reddish surface, which bulged strongly forwards. Taking this to be the front of the cyst, and having ascertained before the operation that the cyst was dull on percussion, I was about to leave this, for twenty-four hours, to become adherent before it was incised. The result proved that, if I had done so, the scalpel would have passed through both walls of the stomach. Before dressing the wound, I again scrutinised the surface of the supposed cyst, and thought I found evidence of involuntary muscular fibre, which threw doubts upon the swelling being a pancreatic cyst. When the supposed cyst was examined between the fingers, it proved to be the empty stomach, stretched very tightly over the subjacent cyst. To get at this, the stomach was drawn upwards, that it might be packed away above under the liver. But here an embarrassing difficulty arose. As I pulled up the stomach, which was tightly jammed between the bulging cyst behind and the parietes in front, the omentum came up into the wound in front of the cyst. The tension of the parts was so great, owing to the rapid increase in the cyst, that there was no room above in which to pack away the omentum. Pushing this to either side, already fully occupied, pulled down the stomach again. I accordingly drew the greater part of the omentum out of the wound.* Some of it was tied with catgut, and cut away; much of it was left heaped up on the abdominal walls on either side of the incision. One or two fine catgut sutures retained the omentum in position. I next scratched through the two layers of omentum, and exposed the surface of the cyst for a space the size of a shilling. There was thus a somewhat conical passage leading from the abdominal incision, through a mass of omentum, down to the anterior surface of the cyst. This last was very vascular, and so tense that it was not thought advisable to put in a guide-suture. The patient passed through the next twenty-four hours fairly well. At midnight, August 23, symptoms of collapse set in (hæmorrhage probably took place at this time into the cyst, a complication which must always be probable, owing to the very vascular surroundings). The patient's pulse at 2 A.M. had run up to 163, and his condition pointed to a fatal ending at no distant date. At 3 A.M. I passed a fine trocar into the cyst, and drew off 12 oz. of deeply blood-stained fluid, which was under very high tension. The sac was then incised and a large drainage-tube inserted. A marked improvement at once set in. A slight discharge of dark treacly fluid necessitated changing the dressing twice a day at first. The wound was all healed in two months (*vide infra*).

On another occasion I should prefer to pack around and empty the cyst at once either by aspiration or by a large trocar and tubing, or by a small incision, keeping the cyst well forwards by means of Spencer Wells's forceps attached to the cut edges. Then, as the cyst emptied, a finger as a guide having been introduced into the cyst and pushed downwards and outwards below the left infra-costal margin, a counter-opening might be made and a large drainage-tube inserted into the cyst from behind. This would be shortened from time to time, as gradual contraction of the cyst took place. The anterior opening in the cyst could be either sutured, or attached to the margins of the abdominal incision. Mr. Cathcart left the opening in the front of the cyst open, Mr. A. P. Gould closed his by suture.

Woch., No. 46, 1890). In two cases the preliminary puncture was followed by evidence of peritonitis, and in two by grave collapse attending the escape of fluid from the cyst into the peritonæal sac. Another possible danger is puncture of the transverse colon, which may be tightly stretched over the cyst. If fluctuation can be detected in the infra-costal region behind, or if a thrill can be obtained here from the front, it will be safer to aspirate from behind.

* On another occasion I should divide the omentum above the transverse colon.

Mr. Caird (*Edin. Med. Journ.*, Feb. 1896) acting on Mr. Cathcart's plan of making a counter-opening behind, opened one of these cysts at the back, and not through the anterior abdominal wall, as is usually done. The incision was made along the outer border of the erector spinæ just below the twelfth rib, and a tube inserted. This was kept in for four months, and later on iodine was injected occasionally to promote obliteration of the cyst. The patient was ultimately discharged, with the opening closed. The administration of liquor pancreaticus with the food was thought to have been beneficial. All will agree with what Mr. Cathcart claims for the posterior incision, viz., (1) that the cyst can here be reached extra-peritonæally; (2) that this incision gives better drainage; and (3) that by it there is less risk of a ventral hernia, but the anterior incision is far better for exploratory purposes, and moreover anterior drainage has been found to suffice in most cases. I have seen one pseudo-cyst drained successfully through the anterior part of an incision made for the exploration of a supposed hydronephrosis.

The after-history of any case of pancreatic cyst reported as cured by drainage must be carefully watched. It is clear that under certain conditions—*e.g.*, where the cyst is very large, where it has thick walls, and above all where the duct communicates with the cyst and where much of the tissue of the pancreas remains—**recurrence** is almost certain and complete obliteration by drainage probably impossible. As in most of these cases the intimate relation of these cysts with very vital parts does not admit of their being dissected out, we must be prepared to fail sometimes in our efforts to secure a radical cure. This is shown by the sequel to Dr. Newton Pitt's and my case, which was brought, as one treated successfully by drainage, before the Medico-Chirurgical Society (*vide supra*). About a year later I heard that the swelling had reappeared and that the man was about to be operated on again. Later on I was given to understand that the swelling had reappeared a second time, but I have been unable to obtain the needful information. Dr. M. H. Richardson, of Boston, drew attention to this tendency of pancreatic cysts to recur after drainage. "Pancreatic Cysts apparently cured by Incision and Drainage; Recurrence; Perforation of the Stomach; Death; Autopsy" (*Boston Med. and Surg. Journ.*, vol. cxxvi. 1892, p. 441). At the necropsy it was found that the head of the pancreas was normal, and that a tube could be passed from the pancreatic duct into the cyst; about two inches of normal pancreatic tissue were found lying between the cyst and the spleen. From this also a duct could be traced into the cyst. It was very difficult and even impossible at the time of the necropsy to dissect out the cyst from the parts to which it was adherent. Dr. Richardson thinks that in some cases the permanent use of a tube will be needful. Mr. A. P. Gould published (*Lancet*, vol. ii. 1891, p. 290) a case of pancreatic cyst which had been treated by drainage, a sinus persisted in spite of treatment, and, three years later, became the site of epitheliomatous infiltration. Dr. O. Ramsey, of Baltimore, in a case of a large pancreatic cyst treated by drainage, was obliged to continue the use of a drainage-tube seven months after the operation, as the discharge was still free (*Ann. of Surg.*, Dec. 1895). Dr. Ramsey thinks that in addition to persistence of secretion the large size of the cyst

and the tension under which the fluid escapes when the cyst is opened, point to gland substance being present and still functionally active. The last two features, it will be noticed, were present in Dr. N. Pitt's and my case, which recurred after an apparent cure. Some of these recurrences may have been due to the adenomatous or primarily malignant nature of the cyst, and for this reason it is always advisable to remove some of the wall of the cyst for microscopical examination.

Extirpation.—On account of the slow recovery and occasional recurrence after evacuation and drainage, extirpation has been practised and recommended, but it is not often either advisable or practicable on account of the extensive adhesion to vital parts, and the large blood-vessels in and around the cyst.

Even Mikulicz had to abandon two attempts, and the splenic vessels had to be tied in two instances (Mikulicz and Billroth). When the cyst is peduncled or chiefly concerns the tail, it may be safely and very properly excised, the pedicle being ligatured, sutured, or clamped.

Mayo Robson (*loc. supra cit.*) collected the records of 160 operations for pancreatic cysts; 140 of the patients recovered from the operation or were presumed from the records to have recovered. Four of the cases were doubtful in this respect. Out of 138 patients treated by incision and drainage 16 died—a death-rate of 11·6 per cent. Out of 13 complete excisions three died (20 per cent.). Out of seven partial excisions one died (14·3 per cent.).

It must be remembered, however, that only the most movable and comparatively small cysts were excised, so that the figures do not represent the comparative danger of drainage and extirpation, the latter of which is only suitable for occasional cases. It is interesting to notice that eight of the patients died of peritonitis, two from shock, one from collapse, one from intestinal obstruction, and one from gangrene of the pancreas. Out of the patients who survived the operation one died later of diabetes, one from tuberculosis, and one from hæmorrhage after a year-and-a-half.

GROWTHS OF THE PANCREAS.

Very few operations have been undertaken for new growths of the pancreas. The most common malignant neoplasm is carcinoma, especially of the head of the gland; but occasionally fibro-sarcoma occurs.

Mr. Mayo Robson (*Hunterian Lectures, loc. cit.*) collected records of 16 operations for the removal of solid tumours of the pancreas, with eight recoveries from the operation, but the prolongation of life was of short duration.

Mr. Malcolm removed an enormous fibro-sarcoma of the pancreas from a child, but the patient died of shock soon after the operation, and the portal vein was found at the autopsy to be full of growth (*Trans. Path. Soc.*, vol. liii. p. 420).

Mr. Mayo Robson records the results of 28 operations for malignant disease of the head of the pancreas. These were undertaken chiefly with a view of making a diagnosis between chronic pancreatitis and carcinoma. Of 15 cholecystostomies eight recovered, but the longest survived only for eight months, and the average duration of life after the operation was only four months. Out of six cholecystenterostomies only two recovered, and they only survived for a few weeks.

Out of 12 cholecystenterostomies for malignant disease undertaken by Dr. Murphy only two recovered from the operation.

It may be concluded that it is not worth while, nay, that it is even wrong to perform palliative operations for malignant growths of the pancreas, and that radical operations are very rarely possible, and so far have not been attended with sufficient success to justify their performance.

Very rarely it may be possible to remove a growth of the tail or body if discovered very early. Malignant cysts may be occasionally drained with temporary relief. Growths of other organs such as the stomach or the colon which trespass upon the pancreas are nearly always best left alone; and if the pancreas is either accidentally wounded or a part of it purposely resected, it is essential to drain the wound to prevent contamination of the peritonæum with the secretion that oozes from wounds of the pancreas.

CHAPTER XI.

OPERATIONS ON THE BLADDER.

REMOVAL OF GROWTHS OF THE BLADDER.—OPERATIVE TREATMENT OF TUBERCULAR ULCERATION.—LATERAL LITHOTOMY.—SUPRA-PUBIC LITHOTOMY.—MEDIAN LITHOTOMY.—LITHOTRITY AND LITHOLAPAXY.—PERINÆAL LITHOTRITY.—REMOVAL OF STONE IN THE FEMALE.—CYSTOTOMY.—RUPTURED BLADDER.

REMOVAL OF GROWTHS OF THE BLADDER.

Chief Varieties.

I. *New Growths from the Mucous or Sub-Mucous Coat:—*

(1) Papilloma (including the two varieties of Sir Henry Thompson), viz., (a) The fimbriated papilloma or villous growth; (b) Fibro-papilloma, which is much rarer, and is almost smooth upon the surface as seen with the naked eye.

(2) Fibrous polypi.

(3) Myxoma.

(4) Sarcoma.

(5) Angioma.

II. *New Growths from the Muscular Coat:—*

Myoma.

III. *New Growths arising from the Epithelial and Glandular Tissues:—*

(1) Adenoma.

(2) Carcinoma, either squamous or spheroidal-celled: (a) Villous variety; and (b) Flattened variety, infiltrating early, and very malignant and difficult to remove satisfactorily.

(3) Dermoids.

Sir Henry Thompson has also described a transitional form of papilloma, characterised by vascularity and cell infiltration. It is not at all easy to tell, either with the naked eye, the cystoscope, or even with the microscope, whether any given villous tumour is or is not certainly innocent or malignant, for the one merges into the other, without any sharp line of demarcation. Growths from neighbouring tissues may invade the bladder especially from the prostate and rectum.

Practical Points in the Diagnosis.—Early and accurate diagnosis is here of the utmost importance.

(1) *Hæmorrhage.*—This is of much importance both in diagnosis and in its bearing upon an operation. Symptomless hæmaturia of

vesical origin is very characteristic of growth of the bladder. Sir Henry Thompson laid much stress on the fact that, in these cases, the stream often begins without any or with little blood, and ends of a bright red colour. Pure blood may be expressed by the final efforts of the bladder as it closes upon and compresses the growth. Bleeding forms the initial symptom in a large number of cases, especially when the growth is of the villous type. Mr. Hurry Fenwick (*Tumours of the Urinary Bladder*, 1901) states that hæmaturia is the first sign in about 84 per cent. of benign papillomata, and in about 75 per cent. of the cases of villous carcinoma, and about 60 per cent. of the bald malignant growths.

In villous growth or fimbriated papilloma hæmorrhage alone may kill, and it may be the only symptom throughout. In these growths the chief point is that the hæmorrhage extends over a long time,* occurs spontaneously and suddenly, and without any allied symptoms; it ceases in the same way; the periods of intermission gradually become less, till the bleeding is constant, either rendering the patients utterly anæmic or adding to their misery by bringing about cystitis. These two last conditions may be so marked as to demand an operation. This symptom is most frequent in the villous growth (fimbriated papilloma), less so in the fibro-papilloma or in the "transitional" growths. In the flat carcinomatous or epitheliomatous growths hæmaturia is more frequently associated with other symptoms and it is less profuse; but repeated small hæmorrhages with only short, if any, intermissions, occur and exhaust the strength of the patient; and the blood is often dark from decomposition and is more diffused throughout the urine.

(2) *Sudden arrest of the Stream of Urine*.—M. Guyon (*Ann. de Mal. des Org. Gén.-Urin.*, 1889, p. 449) points out that in a few cases a pedunculated growth situated near the neck may cause obstruction and other micturition troubles, before hæmorrhage appears.

Mr. Hurry Fenwick estimates that sudden arrest of the stream occurs as the initial symptom in about 8 per cent. of the benign villous, and about 10 per cent. of the malignant villous growths: whereas it is very rarely noticed with the flat or bald variety of carcinoma.

Any tumour which grows quite near or infiltrates the tissues around the urethral orifice of the bladder may cause obstruction to the flow of urine sooner or later, and this may simulate carcinoma or even senile enlargement of the prostate.

(3) *Unilateral Renal Pain*.—Growths are so very frequently situated at or quite near to one or other ureteral orifice, that they often obstruct it either by dragging, or compression from infiltration. Hence

* Mr. R. Harrison (*Intern. Encycl. Surg.*, vol. vi. p. 38) states that in the Museum of St. George's Hospital there is a specimen of a villous tumour attached to the neck of the bladder of a gentleman aged 81. The first attack of hæmorrhage had occurred twenty years before death, and had lasted for eight months. An interval of four years had followed this, and then a recurrence of hæmorrhage, which ultimately proved fatal. Sir B. Brodie also states that the disease occasionally extends over seven or eight years. In a case of the late Mr. W. Anderson's (*Clin. Soc. Trans.*, vol. xviii. p. 313), of papilloma, the first hæmaturia had taken place twelve years before, then came an interval of a year, followed by recurrence of the hæmaturia, the next interval being shortened to six months, after which recurrence took place fairly regularly every three months.

dilatation of the ureter and renal pelvis or pyelitis may develop and cause pain in the corresponding loin.

This may be the initial symptom of vesical growth occasionally, and the kidney has been needlessly explored in some cases under these circumstances. This symptom, which may serve to localise the growth, is noticed earlier with benign papilloma than with villous carcinoma, which obstructs by infiltration around the ureteral end.

(4) *Frequency of Micturition* and other symptoms of vesical irritation are most frequently associated with the infiltrating flat growths, and they are least common with benign villous tumours. Fenwick estimates that these symptoms are the initial ones in about 30 per cent. of the bald carcinomata, 15 per cent. of the villous carcinomata, and only 8 per cent. of the simple villous papillomata. Pain is more frequent and most severe with infiltrating carcinoma.

(5) *Examination of the Urine*.—This aid has been too much neglected because the naturally present “transitional” epithelium of the bladder may so easily be mistaken for growth cells. But, in the case of villous growths especially, careful examination of the urine should be frequently made, and the patients directed to bring, at once, any white or shreddy particles passed. The delicate papillæ, with their connective-tissue basis supporting hosts of columnar cells with large delicate capillaries, are most characteristic. Recognisable fragments are more rarely cast off the malignant villous growths, and when any are found, they give no indication of the nature of the base of the tumour; the villi may be innocent in appearance, and yet the base may be malignant. It is uncommon for the bald or flat growths to shed any pieces until the late sloughy stage, but when seen microscopically, the fragments are characteristic enough. It is very important to ascertain the total amount of urea passed in the 24 hours, for if the excretion is seriously lowered, no operation should be undertaken on account of the danger of death from uræmia. Marked wasting is very characteristic of malignant disease of the bladder.

(6) *Rectal Examination*.—This should never be omitted, for with the bladder empty of urine, the finger may detect a thickening, hardness or rigidity of the base above the prostate, indicating an infiltrating growth. Usually the mass is separate from the prostate, but in late cases the latter may not be distinct from the growth. A benign growth cannot be felt per rectum, and the villous carcinoma may only indicate its presence by an unusual fulness or heaviness of the bladder, but a carcinoma which infiltrates the vesical wall soon becomes palpable, and Fenwick states that quite 50 per cent. of these growths are palpable per rectum, within a year of their origin. A rectal examination may thus enable the surgeon to dispense with cystoscopic or other examinations of the interior of the bladder, for in these cases an operation is nearly always futile, and a mere cystoscopic examination is not free of danger in them. The patient should be examined in the kneeling attitude as well as in the supine position, for the former posture enables the surgeon to feel higher up the posterior wall of the bladder. Bimanual examination with the patient supine, and the abdominal wall relaxed, may discover infiltrating growths placed in unusual positions such as at the fundus or on the anterior wall. In the female vaginal examination should be conducted in a similar way.

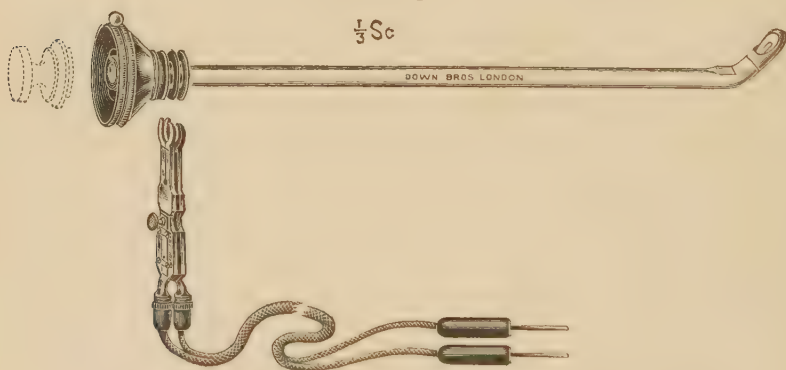
At the present day it is quite unnecessary and unjustifiable to sound any patient suffering from hæmaturia only, for a stone is extremely unlikely to be the cause, and to try to detach pieces of growth for examination is foolish. When this method was used before the days of the cystoscope, it often failed in its purpose, and seriously aggravated the hæmorrhage, and not uncommonly it was followed by cystitis, even when all care had been taken in ensuring asepsis.

(7) *The Cystoscope.*—In skilful hands the cystoscope is of great value in the detection and examination of vesical growths, and it enables the surgeon to decide for or against an operation.

It serves to exclude renal causes of the hæmaturia, and to define the nature, size, number, position, and character of the basal attachment of the growths, and also the presence or absence of infiltration of the vesical wall.

Hence the knowledge gained through the cystoscope may indicate the exact nature and degree of surgical interference that may be

FIG. 230.



Max Nitze's cystoscope (No. 21, French gauge), with Pardoe's eyepiece.

required, so that the surgeon can adopt the most suitable method without waste of time during the actual operation.

There are certain precautions to be carefully observed in using the cystoscope, and there are limitations to its use and value.

It is not enough for the surgeon to be able to see abnormal conditions in the bladder, but he must be acquainted with the many varieties of normal bladders, and also able to interpret what he sees. For this considerable practice is required, and a sound knowledge of the pathology of the bladder.

It is imperative to conduct the examination aseptically, and with all gentleness, so that neither cystitis nor hæmorrhage may follow. In many cases with infiltration of the bladder-base, which is palpable from the rectum, it is not necessary to examine the interior of the bladder, for the time for radical operative interference has already passed.

In certain cases hæmorrhage may be so profuse in spite of all gentleness, injections of adrenalin, nitrate of silver, &c., that the cystoscope may fail to give any information of value.

It is wise to wait for an interval in these cases, the patient being kept at rest in bed, and when the urine has become clear, the bladder

may be examined through this medium to avoid the risk of setting up fresh hæmorrhage by irrigation.

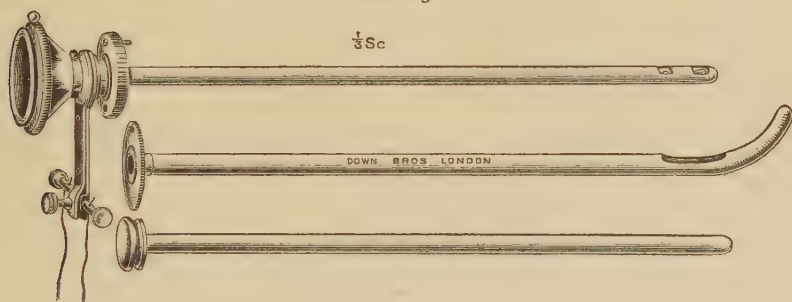
To check the bleeding three or four ounces of a $\frac{1}{10000}$ solution of adrenalin chloride may be introduced and left in the bladder for a few minutes. In other cases a weak solution of silver nitrate (grs. ii to the ounce) may succeed after adrenalin has failed. An irrigating cystoscope may be of great value when oozing persists in spite of all endeavours to check it; quick work with an ordinary cystoscope will succeed unless the bleeding is profuse.

Hæmorrhage is likely to be troublesome with friable growths which surround or grow near the vesical orifice of the urethra; bleeding from over-distension and rough handling is avoidable.

A very large growth may not allow proper illumination, the beak of the instrument being more or less surrounded by villous processes, or prevented from entering the main vesical cavity.

I only occasionally use a general anæsthetic, and then only for young women or for painful conditions. A 10 per cent. solution of

FIG. 231.



Güterbock's cystoscope (modified by Mr. Hurry Fenwick) for irrigation. The outer cannula is introduced with the help of pilot, or snugly-fitting flexible catheter to close the opening; the bladder is then washed out with syringe or syphon, and filled with clear medium; finally the cystoscope is pushed inside the outer cannula for examination of the bladder.

cocaine milked back along the urethra of the male, or injected into the urethra of the female, generally suffices. A drachm of a 20 per cent. solution of cocaine may be added to the medium for painful conditions and nervous patients if the examination is likely to be difficult or prolonged (Fenwick). This makes a tender bladder relax sufficiently to admit enough fluid, and enables the patient to retain the liquid without much discomfort during the examination.

The urethral orifice is covered with cotton wool soaked with cocaine solution.

An aseptic soft silk catheter* with a very large but smooth eye is then passed gently, and the bladder is washed out very thoroughly

* I generally use a child's evacuator when hæmorrhage is not anticipated; this is a little smaller than the cystoscope, and has the same shape, so that it is as easily introduced as the cystoscope. It has the advantage of being certainly aseptic, for it can be boiled just before use, and it possesses a very large eye, which greatly facilitates and accelerates the washing out. When gently used, and only introduced just within the bladder, it is not likely to induce hæmorrhage—no more likely than the cystoscope.

and carefully with warm sterile boracic lotion. Hydrostatic pressure is the best to use, for it can be so well regulated by depressing or elevating the graduated funnel. Directly the patient feels the bladder to be full, the funnel is depressed, and a mental note is made of the capacity of the bladder. When the escaping fluid becomes quite clear, from six to eight ounces of the solution are run in, if the bladder can comfortably hold as much. A satisfactory examination cannot be made with less than about four ounces, and the upper part of the bladder becomes invisible if too much fluid is injected. In any case it is absolutely essential for the medium to be quite transparent.

The patient may be either lying down with the thighs separated, or placed in the lithotomy position. I prefer the former attitude except for very stout patients. The external genitals are thoroughly cleansed with soap and water and a weak solution of lysol, and an aseptic towel with a central slit in it is applied so that the examination can be conducted aseptically. The surgeon's hands are cleansed as for an operation. The cystoscope, which has been previously tested and found to be in good working order, has its beak and stem immersed in a $\frac{1}{100}$ solution of lysol during the preparation of the bladder and the cleansing.

The beak and stem are lubricated with glycerine, and the instrument is gently introduced. The light must not be turned on until the beak has reached the bladder, and care must be taken not to touch the vesical-wall with the beak, for the contact, if prolonged, may cause a burn.

The ureteral orifices and the trigone are first sought and examined, for in the great majority of cases growths and other pathological conditions are to be observed at these situations. The knob upon the rim of the cystoscope indicates the direction of the light, and when it is turned downwards and outwards to either side the corresponding ureter is seen. If the circle of rotation be compared to the face of a clock, the ureters will be found when the indicator points towards five and seven o'clock, if the beak is neither too far from or too near to the urethral orifice. Normal urine, blood, pus, or methylene blue may be seen to be discharged at intervals from the ureters, or a tumour may be seen near them or upon the trigone. The beak is turned downwards and backwards to examine the lower part of the base; the pouch behind an enlarged prostate cannot be easily seen. When the base has been thoroughly examined, other parts are scrutinised in turn. The light can be regulated to a nicety by means of a rheostat placed at one of the terminals of the battery. If the medium becomes cloudy the instrument should be withdrawn and the bladder irrigated again, unless an irrigating cystoscope is used. When the examination has been completed the light is turned off and after a few seconds the instrument is withdrawn. If the bladder is uncomfortably distended, and the patient cannot empty it, a catheter should be passed at once.

For the safe use of the cystoscope it is essential to conduct the examination aseptically, and for the evidence which it affords to be reliable, it is necessary for the surgeon to have acquired skill both in the use of the instrument, and a considerable experience of normal and abnormal cystoscopic views. For the introduction of the instrument the urethra must be large enough to admit a No. 22 French

catheter, so that when a stricture is present it is necessary to dilate or divide this first, and when the meatus is unusually small it must be enlarged. For obtaining a proper view the medium must be absolutely clear, and the bladder must be capable of holding at least four ounces of it. Growths, tuberculous and simple ulcerations, diverticulæ, calculi, vesical projections from an enlarged prostate, and a variety of other conditions, may be seen through it, as well as valuable localising signs of renal disease. It must be used with judgment, and not indiscriminately, for any of these conditions. In many cases of enlargement of the prostate, for instance, the introduction of the instrument may be impossible or may be attended with considerable difficulty, so that more harm than good may follow its use under these circumstances, and especially if there is much cystitis. The diagnosis is frequently clear enough without the cystoscope, although in certain cases, with little or no enlargement to be discovered from the rectum, the instrument is of great value.

(8) *Dilatation of the Female Urethra* with Kelly's dilators and either visual or digital examination of the bladder is valuable. The former is by far the best, for it needs less dilatation of the urethra, and avoids any risk either of laceration of its mucous membrane or of incontinence of urine. Above all, sight is infinitely more accurate and reliable than touch. Electric cystoscopy, however, disturbs the patient less than either, and is therefore to be preferred for the purpose of diagnosis, except in the rare cases where this method fails on account of hæmorrhage, and where treatment is to follow the diagnosis immediately.

(9) *Supra-pubic Cystotomy*.—In males, where the cystoscope fails or is not available, I strongly advise supra-pubic cystotomy to clear up the doubt in these cases. If a removable growth be discovered, it should be removed at once.

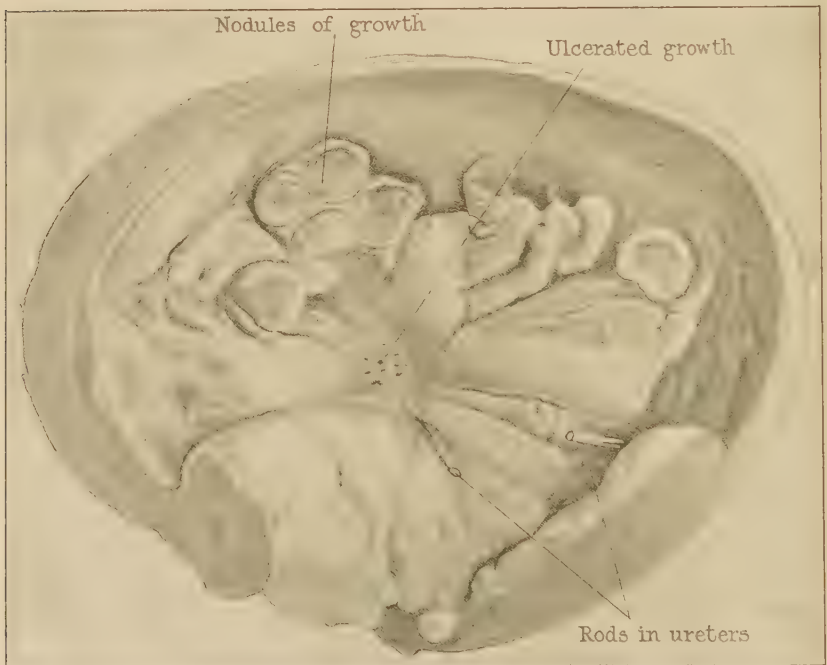
(10) *Exclusion of other Conditions*—e.g., stone, tubercular and other forms of cystitis, also hæmorrhage—from the prostate or kidney. In none of these cases, save in the last, is there the spontaneous character which often marks the bleeding of bladder growths. In renal hæmaturia due to growth the bleeding may be spontaneous, and unaccompanied by other evidence. Here the renal region should be thoroughly examined at regular intervals, but the cystoscope and the segregator will clear up the diagnosis, as in the case related at p. 160. In tubercular disease of the bladder the bleeding is never as severe as in growth, and for a long time occurs only at the end of micturition. Other evidence will also be present, and so, too, with the hæmorrhage of enlarged prostate, which will very likely be preceded by a chill or by retention.

Indications for Operation.—Growths of the bladder being nearly always fatal, whether from hæmorrhage, or pain, or the results of obstruction, or from these combined, the surgeon is entirely justified in urging an early cystoscopic examination to clear up the diagnosis, and to decide the question of removal. If the cystoscope fail, which it rarely does, digital and visual exploration should be advised. Supra-pubic cystotomy should be performed in the male, and urethral dilatation in the female. While it remains as yet uncertain how many of the cases published as cures are really and permanently so, even in the

case of the villous growth, it is an undoubted fact that an operation may result in arresting the hæmorrhage completely for years. In other cases, hæmorrhage, pain, and frequency of micturition may all be very largely relieved. Where little or nothing can be done in the way of removal, the free escape given to the urine by a supra-pubic operation or by dilating the neck of the bladder in a woman may give great relief; where even this fails, the diagnosis has, at least, been cleared up.

If in doubt as to recommending cystoscopic examination or exploration, the practitioner should remember—(1) that the long intervals between the bleedings teach strongly that growths of the bladder often

FIG. 232.



Flat and infiltrating epithelioma of the bladder. The central part of the extensive growth has ulcerated. (Guy's Hospital Museum.)

pass through a long first stage, during which the growth is connected with the mucous membrane only; (2) that, following on the above, infiltration of the deeper coats, and thus glandular infection, is often here long delayed. While the long intervals between the bleedings, and the comparative slightness of the other symptoms, may make the surgeon unwilling to urge operative interference, it is right that it should be very clearly put before the patient that it is in this stage only that any hope of a radical cure can be given, and that later on, when the stage of infiltration is reached, not only is radical cure almost out of the question, but the risk of attempting it is vastly increased. The points that a careful and skilful cystoscopic examination or a supra-pubic exploration will clear up about the growth are

the number, site, whether accessible or not, and its relation to the ureter, how far pedunculated or sessile, how far it seems attached to the coats of the bladder. There is a general belief, I think, that pedunculated growths are usually benign. This is a very dangerous belief. Malignant growths or transitional ones becoming malignant form the very great majority of bladder growths. If the growth is at all thick or succulent, if it is at all infiltrating—*i.e.*, not a merely implanted pedicle—the odds are greatly in favour of recurrence, however thoroughly the growth is removed. Of 28 cases of pedunculated growths examined by Albarran 15 were malignant.* In apparently simple cases recurrence may take place in spite of the most complete operation (*ibid.*). The more the growth approximates to the worst of all types of bladder growth—*viz.*, the low-lying, broad-based, fixed, sessile lump, especially if with a sloughy surface encrusted with phosphatic *débris*—the more hopeless is operative interference (*vide* Fig. 232). If the renal function is seriously impaired, or if there is any sign of metastases or extensive local infiltration palpable from the rectum or vagina, no operation should be undertaken, except for drainage as a palliative measure in some cases of obstruction of the urethra.

Choice of Operation.—In my opinion, in all cases, but especially where the surgeon is uncertain as to the size or the number of growths, where the perinæum is very deep, where the prostate is enlarged, or the perinæum small and the pelvic outlet contracted, the supra-pubic method will be safest, gives by far the best view and most room. So, too, in the case of a recurrent growth, this method should be employed, as it cannot be told how far the recurrence is widely diffused. The supra-pubic operation is always to be preferred as enabling one to see as well as to touch the growth, as alone giving more room for necessary manipulations, *e.g.*, the use of an electric lamp in what may be a very difficult operation.†

The perinæal route has been advocated for single small growths near the neck of the bladder, and also for arresting hæmorrhage in a few desperate cases, in which perinæal section is the quickest method.

* It is always worth while to remember the vast preponderance of malignant over benign growths of the bladder (Wallace, *Edin. Med. Journ.*, 1893, p. 735). Thus out of 88 cases which Albarran personally examined 71 were malignant, and 17 simple. Out of 22 cases Guyon found 19 to be malignant.

† It is noteworthy that all the surgeons of widest experience have declared for the supra-pubic method—*viz.*, Sir H. Thompson, Guyon, Volkmann, Dittel, von Antal, &c. Sir Henry Thompson thus drew attention to the great risk of making strong supra-pubic pressure while forceps are being used through a perinæal wound: "If that pressure is considerable, it forces the upper wall of the bladder into its own cavity, and thus gives the growths a larger contour than they possess, and makes them apparently salient to a much greater extent than they really are. Thus an eager or inexperienced operator, unaware of the effects of strong supra-pubic pressure, might be led to seize the mass offered to the forceps through the influence of this pressure, and, under the belief that it was a large growth, he might inflict a fatal wound by crushing a double fold of the coats of the bladder, and so make an opening in the peritonæum. To avoid such a catastrophe, it is only necessary, first, to decline the attempt to destroy any growth which is clearly not sufficiently saline to admit of complete or nearly complete removal, and, secondly, never to employ the forceps while forcible supra-pubic pressure is made—at least, no more pressure than is desirable just to steady and support the bladder and the parts adjacent."

In such cases the bladder has been explored from the perinæum by opening the membranous urethra, and dilating the vesical neck. But even here I do not recommend it.

In some cases it will be advisable to combine both operations, as the perinæal opening enables the surgeon to use two index-fingers in the bladder at the same time, and also favours drainage, especially where the urine is foul.

In cases where, owing to complete removal having been an impossibility, it is desired to give relief by a permanent opening, a supra-pubic one kept patent by a short curved tube and plate (somewhat like a tracheotomy-tube) will be preferable to a perinæal opening, owing to the tendency of the latter to close, and the basal position of the growth in nearly all cases, and the comparative freedom of the anterior wall until very late in the disease.

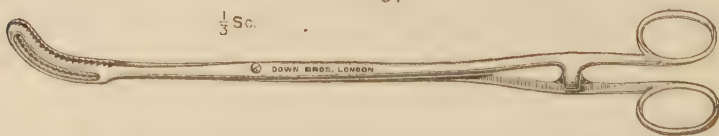
FIG. 233.



Caisson for examination of the bladder through a supra-pubic wound.

the intended opening into the bladder with a curved needle in a handle. The opening into the bladder is then made (carefully, so as not to divide the underlying silk), and the silk is hooked up and divided; by this means two or four sutures are present, which will serve to raise up the bladder as required, and to keep it well open and within reach during

FIG. 234.



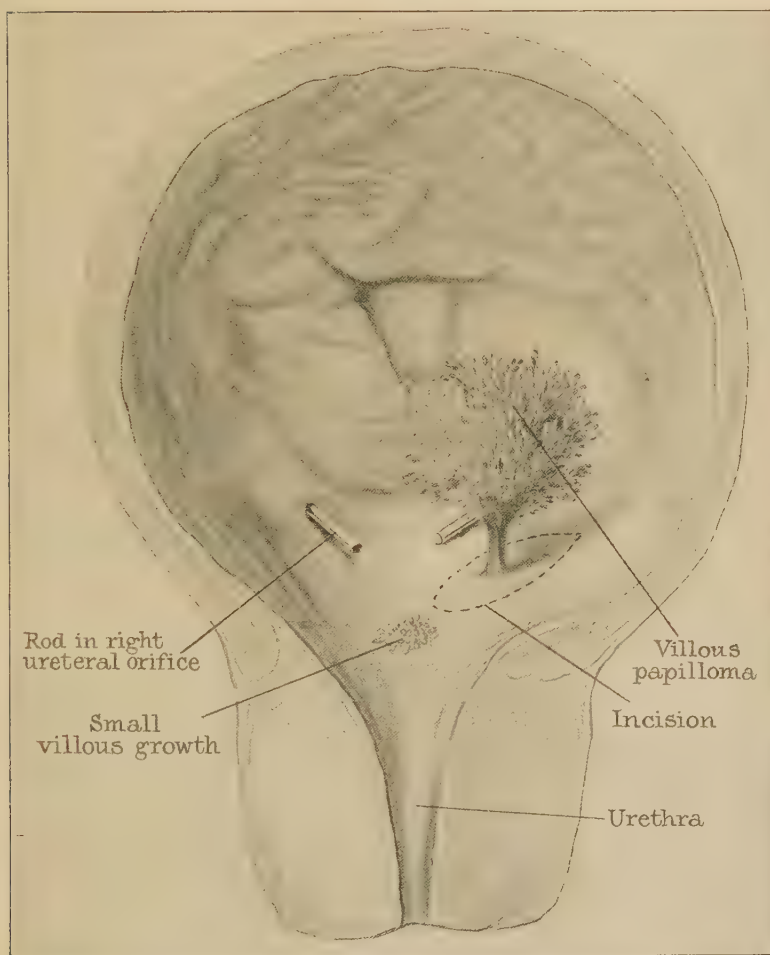
Forceps for seizing bladder growths. (Hurry Fenwick.)

the manipulations required for the removal of the tumour.* I prefer the use of two fine tissue-forceps on either lip of the wound, held by assistants, the threads when pulled upon being liable to tear the delicate tissue of the bladder. Suitable tissue forceps inflict no serious damage. The finger of an assistant in the rectum serves to push the base of the bladder up in difficult cases, and is far safer than a rectal bag. This

* In difficult cases the position of Trendelenburg (p. 612) is always to be employed. The intestines gravitating towards the diaphragm drag upwards the peritonæum, and thus the bladder slightly. The deeper parts of the viscus can now be better brought into view, especially with an electric lamp.

assistant must not take any other part in the operation. In opening out and exposing the cavity of the bladder, specula* of wire (solid-bladed ones taking too much room) will be found very useful, and a caisson illuminated with a forehead lamp is invaluable, for a clear view of the growth and operation area can be thus obtained without

FIG. 235.



Simple villous papillomata of the bladder. (Guy's Hospital Museum.) The mucous membrane around the base is removed as indicated in the figure. The ureteral orifices were free of growth in this case.

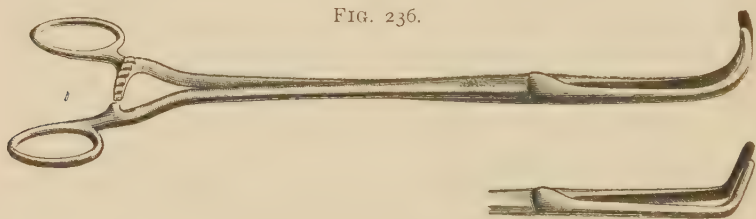
the need of frequent sponging. The parietal wound is also less exposed to contamination and bruising (*vide* Fig. 233).

* Of these special instruments the bladder-speculum with two wire blades invented by Watson, of Boston (*Lancet*, Oct. 18, 1890), and the three-jawed speculum of Bruce Clarke (*Brit. Med. Journ.*, July 4, 1891), are the best.

To minimise hæmorrhage and thus improve the view, a solution ($\frac{1}{1000}$) of adrenalin chloride or of hemisine can be applied through the caisson before the base of the growth is excised. The removal of the growth is effected in different ways according to its size and structure.

Appropriate forceps, straight and curved, those with serrated blades introduced by Sir Henry Thompson or those of Fenwick, may be used to seize the pedicle of the growth (*vide* Figs. 234, 236). If the tumour is a large one it is a great convenience to get rid of the bulk of it at once after dividing the pedicle in front of the clamp, which prevents hæmorrhage. The division is made with the curved scissors passed down towards the concavity of the twisted jaws of the forceps, the left forefinger being used as a guide. The tumour is then removed with forceps, and attention turned to the stump. This and the adjacent mucous membrane* must be deliberately removed with blunt-pointed scissors, curved upon the flat (Fig. 235). To prevent hæmorrhage Mr. Hurry Fenwick first applies a narrower curved clamp forceps between the first one and the bladder wall, and then cuts between the two forceps. The hæmostatic clamp is left on for twenty-four hours.

FIG. 236.



Useful forceps for seizing the pedicles of villous growths. (R. Harrison.)

The second clamp may be dispensed with if a continuous mattress suture of fine catgut can be placed between the first clamp and the vesical muscle; the base of the tumour is then excised between the suture and the clamps. Very fine catgut does no harm, and is very soon absorbed after it has answered its purpose, but it is often impossible to insert it. It is rarely wise to try to pull the pedicle into the wound with the forceps, for the traction may tear off the stump and lead to profuse hæmorrhage, which is difficult to get under control. It is better to grasp the bladder mucosa near the tumour with tenaculum forceps and to bring the growth well into view with them. In any case the interior of the bladder must be thoroughly examined with the aid of a head light and the caisson before the operation is completed, so that no early and small growth may perchance be overlooked.

In more doubtful cases—cases transitional between innocent and malignant—the following test of Albarran's may be useful: "The gliding or otherwise of the mucous membrane ought to regulate the

* "Even in the most simple cases the removal of the growth should be more extensively performed than is the custom, and all the mucous membrane in contact with the growth should be removed. We have seen the possibility of infection by contact with the mucous membrane, and the plan I propose is to eradicate the epithelial neoplasms that may exist around the growth" (Albarran, *loc. supra cit.*).

depth of the removal of the growth. Wherever the mucous membrane seems fixed to the sub-mucous coat it would be better, even in pedunculated growths, to resect the entire wall, a step still more essential in small sessile tumours" (*vide infra*, "Partial Resection of the Bladder," p. 604). When the growth is of firmer consistence and more of the sessile type, it should be clipped away with scissors, punched out if firm bit by bit with Jessop's prostatectomy forceps, or Fenwick's scoop forceps (Fig. 237).^{*} This procedure only affords temporary relief, and is not to be employed when partial resection of the bladder is practicable.

If we are to progress in our surgery here, a radical cure can only be hoped for in growths that infiltrate the bladder wall by treating them as we do malignant disease elsewhere—*i.e.*, operating early and removing the whole thickness of the tissues affected, as long as this step is not foolhardy (see "Partial Resection," p. 604). Further two warnings of Mr. Fenwick's must be remembered by those who trust to forceps and nibbling or twisting: "Munching the surface of a carcinoma and leaving the base is tantamount to an increase in the rapidity of its growth. I have reason to believe that the munching or squeezing of the healthy mucous membrane in the neighbourhood of the growth fosters the appearance subsequently of growth in the traumatised areas" (*Brit. Med. Journ.*, 1895, vol. ii. p. 906).

FIG. 237.



Fenwick's scoop forceps.

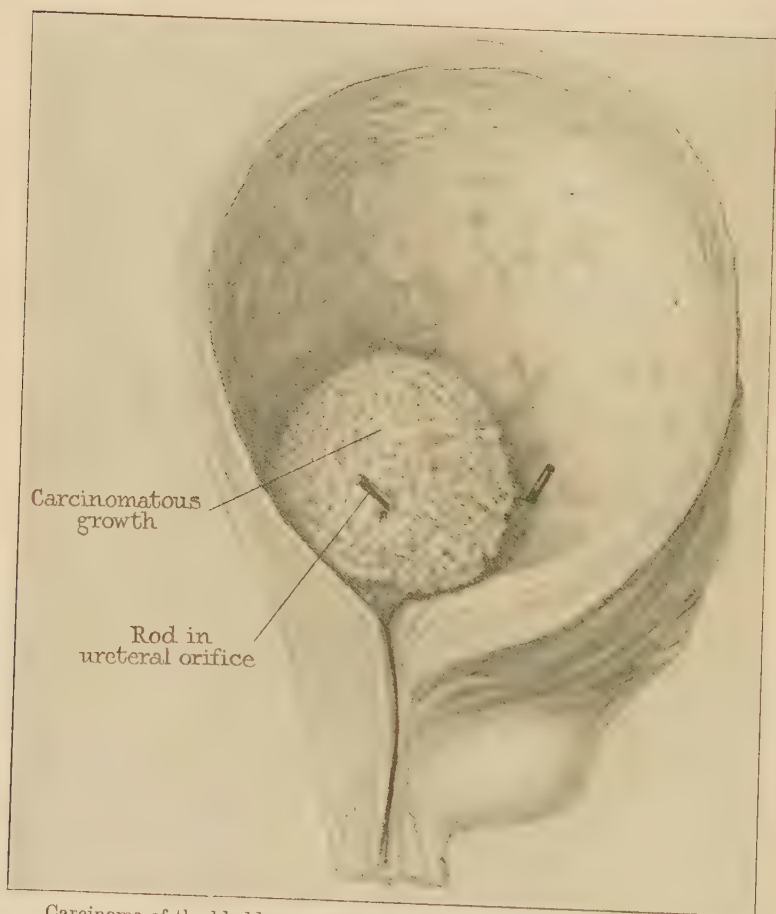
Dr. F. S. Watson in a valuable paper in the *Ann. of Surg.*, 1905 (vol. xlii., p. 805), gives the results of his careful analysis of the records of 653 operations for various growths of the bladder. This number includes the cases published by Albarran in 1892, and others collected or observed by Watson since that time; 243 of the operations were for benign and 410 for malignant growths. From this study Watson concludes that "the sum and substance of the result of operative interference up to the present time may be stated thus: If the operative deaths and rapid recurrences are combined under the one heading of operative failures, such failures are seen to have occurred in the 28·6 per cent. of the benign tumours, exclusive of myxoma, and in 40 per cent. of the cases of carcinoma. . . . The very large percentage of recurrence seems to point logically to the necessity of more radical measures in benign as well as in cases of malignant tumours, if we are to hope for better results."

Dr. Watson even goes so far as to suggest "that total extirpation of the bladder and of the prostate, if it be involved in the pathological process, be done at the outset in all cases of carcinoma that have not

^{*} Whatever method is used, the surface left should be as smooth as possible, in order to diminish the risk of phosphatic deposit.

extended beyond the limits of the above-named structures, and in which it is believed that there are no metastases, and that the same measures shall be applied in all cases of benign growths in which recurrence has taken place after a primary operation for their removal." While fully conscious of the need of adopting more radical measures in all cases, especially of the wisdom of partial resection and even complete

FIG. 238.



Carcinoma of the bladder surrounding the right ureteral orifice. (Guy's Hospital Museum.)

resection in suitable cases by very skilful and experienced surgeons, I cannot endorse Dr. Watson's recommendations in their entirety for the following reasons:—

(1) The immediate mortality of total extirpation has been as high as 56 per cent. in the 25 cases collected by Watson, as compared with 18.6 per cent. in 91 partial resections; but it is likely that the death-rate of both operations will be very considerably diminished in the hands of skilful surgeons, from improvements of technique and a better

selection which increasing experience may enable them to make. The greater risk is compensated to some extent by more freedom from recurrence after total extirpation than after partial resection and other less radical removals of malignant growth. Recurrence is also much rarer after partial resection than after less radical operations for so-called benign papilloma.

(2) The primary difficulties and dangers of ureteral transplantation of every kind and the unsatisfactory character of the ultimate results as regards want of proper control of the urine, and the liability to ascending infection* and ureteral obstruction.

It seems to me that more is to be expected from partial but earlier and more extensive resections than hitherto adopted, but leaving enough bladder for implantation of one or both ureters according to the situation, nature, and extent of the growth.

Hæmorrhage.—This may be met by pressure, suture, or occasionally by ligature, the ends of the latter being brought out through the meatus in the female or the supra-pubic wound in the male. Sutures of very fine catgut may be used. Hurry Fenwick with sessile growths catches the bleeding points through the caisson with artery clips, and then removes the handles of the latter, and withdraws the caisson, leaving the clips on for twenty-four hours.

Hot saline solution at a temperature unpleasantly hot for the hand may be tried if the bleeding persists in spite of the above, and if the bleeding point is on the floor or above the neck. A solution of adrenalin chloride ($\frac{1}{1000}$) should be applied on the bleeding part through the caisson, and followed if necessary by gauze tamponnading. A subcutaneous injection of aseptic ergot or ernutin may be required in some cases. Care must be taken not to leave any bits of growth or clots in the bladder to become the nuclei of stones, and for this reason the bladder must be irrigated before attempting to close the wound either partly or completely.

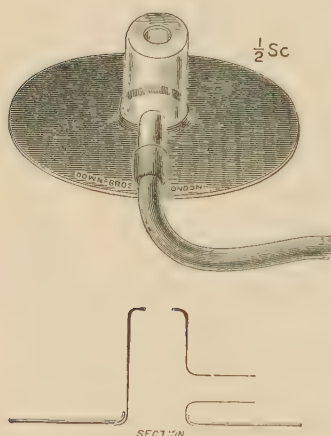
When the operation is completed the question will arise as to the advisability of suturing the bladder. In the after-treatment of all supra-pubic cystotomies, the chief nuisance, and a very great one, is constant soakage of the dressings by the urine. This should be avoided whenever the following conditions make the use of sutures safe: (1) efficient suturing of the vesical wound: a continuous Lembert suture of catgut is employed, care being taken to secure a sufficient hold and inversion without piercing the mucosa; (2) efficient emptying of the bladder; (3) arrest of bleeding, otherwise the catheter will be blocked, the distress great, and much tension will be thrown on the stitches; (4) an aseptic condition of the urine; (5) an operation in which the manipulations have not been very prolonged and difficult,

* Dr. Watson proposes to get over these difficulties and dangers by performing bilateral nephrostomy with ligation of the ureters some four or six weeks before the radical operation. This provides freer drainage than any transplanting operation, and Watson believes that the immediate risk even of the bilateral operation would be much less than that of ureteral implantation. He also states that the annoyances and dangers of bilateral renal fistulæ are small, and avoidable to a large extent. Obviously this method is not suitable even as a palliative measure for irremovable vesical growth, except in the well-to-do, who can provide the needful apparatus for drainage, and obtain the services of a capable nurse permanently.

and one especially in which there has not been much disturbance of the *cavum Retzii*.

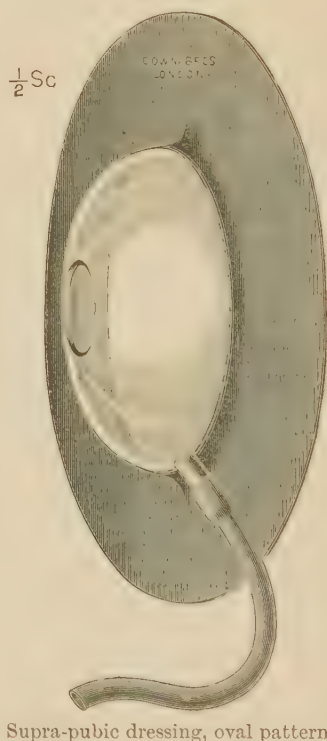
In any case a small drainage tube containing a wick of gauze should pass through the lower angle of the parietal wound down to the line of suture, so that, if any leak occur in the first day or two, urine may not extravasate in the loose cellular tissues of the pelvis, but drain away along the tube and gauze. These can be safely removed after three days. If the surgeon is wisely cautious about suturing the whole of the bladder wound, he will suture it almost completely, and leave in a small closely fitting drainage tube, putting in one or two provisional

FIG. 239.



Colt's supra-pubic dressing, round or cylindrical pattern. A water-tight joint is made between the patient's skin and the rubber sheet by means of a solution of rubber in naphtha. The upper part of the glass capsule is open, so that air may enter it, and syphonage be thus avoided.

FIG. 240.



Supra-pubic dressing, oval pattern.

sutures, which he will tighten up in a few days, when the risk of hæmorrhage and extravasation has passed away. When the conditions given above are not present, and suturing the bladder involves too much risk, the cut edges of the bladder should be united to those of the deeper and lower part of the parietal wound with catgut.

A No. 12 soft and large-eyed catheter is passed through the urethra so that its eye lies just within the bladder, where the point can do no harm.

A medium-sized drainage tube is passed into the bladder. The part that lies within the latter should be fenestrated, and the other end should project a little beyond the lips of the parietal wound, to which it is fixed by means of a salmon-gut suture. Another method of draining is to use an india-rubber catheter, lengthened by a piece of

drainage tube, passed along the urethra, and out at the supra-pubic wound. Several holes should be cut in the part that is to lie within the bladder. Bringing the tube out above the pubes facilitates washing out the bladder both ways.

If the urine does not drain through the catheter, although its end has been properly placed just above the vesical orifice, and the distal end of the rubber tube attached to it is kept under some carbolic lotion, a little boracic lotion should be run through the catheter, for this may serve to dislocate a clot from within it.

If the patient still gets wet syphonage should be employed, but this is easier to write about than to establish and maintain efficiently.* Colt's improved supra-pubic drainage apparatus if carefully applied works admirably (*vide* Figs. 239, 240).

Ureteral drainage is only mentioned to be condemned on account of the danger of ascending suppurative nephritis†, for in many of these patients the kidneys are already damaged.

The Removal of Vesical Growths in Women.—Supra-pubic cystotomy is not necessary for the removal of pedunculated benign growths from the female bladder, for these can be removed through the dilated urethra with less risk, and with little, if any, more chance of recurrence. Malignant and sessile growths must be removed supra-pubically, as in the male. When the surgeon has decided to remove a growth through the urethra, the bladder is washed out, and the urethra is dilated with Kelly's conical dilators. A large Kelly's speculum is then introduced, and the growth is sought and brought into view, and removed as described above (p. 598).

Removal of papillomatous growths with the operating cystoscope of Nitze is not to be recommended, for it is only practicable for very few experts, and even for them the hæmorrhage obstructs the view immediately after the removal of perhaps a part of the growth, and it is impossible to tell whether the removal has or has not been complete. The operation can certainly be repeated if necessary with less disturbance than a supra-pubic cystotomy involves, and the operative mortality is very small in the hands of the very few who can really employ the method.

* The best means of draining the bladder is one described by my friend Mr. Cathcart, of Edinburgh (*Brit. Med. Journ.*, 1895, vol. ii. p. 968). Besides a douche-can, some india-rubber tubing, and a pail, a screw clamp, a small glass Y or T tube, a second piece of glass tubing bent like a capital S, and a third piece bent at a right angle to go into the bladder, are required. The can, filled with water, is fixed over the patient's bed; the Y tube is fastened with a large safety-pin to the edge of the mattress opposite the patient's pelvis. To one limb of the Y tube is attached about a foot of tubing which is connected with the can, to the other a right-angled glass tube, which dips into the bladder. To the stalk of the Y tube a third bit of tubing is attached, which is fixed below to the S glass tube, which by means of another bit of tubing should end under some aseptic lotion. The apparatus being in position, the screw-clamp which controls the rubber tubing between the irrigator and one arm of the Y tube is then relaxed, so as to allow the water to run very slowly, in fact, only by drops. It accumulates in the S tube, and as it tends to run out produces a negative pressure in the other arm of the Y tube—i.e., the one connected with the tube in the bladder, thus withdrawing the urine.

†. Schede has thus kept a tube-catheter in one ureter for several days without any harm resulting.

Whichever way the vesical growths are removed, it is absolutely necessary to keep the patients under observation for a long time. Cystoscopic examinations should be made at regular intervals of about two months, and in this way a recurrence may be discovered long before symptoms arise or the tumour has become inoperable. Intra-vesical injections of nitrate of silver solution may do something towards preventing recurrence (Herring, *Brit. Med. Journ.*, Nov. 28 1903).

Partial Resection of the Bladder for Growths.—A good many cases have been recorded with a sufficient amount of success to justify a repetition of the operation in selected cases. Watson's collected cases included 17 partial resections for papilloma, with one death, four for myoma, with one death, making a total of 21 partial resections for innocent growths, with two deaths, a mortality of 9·5 per cent.

For carcinoma there were 91 of these operations, with 17 deaths—a mortality of 18·6 per cent. It is interesting that this death-rate was less than that for the 222 supra-pubic operations without resection, for the latter were attended by a mortality of 28 per cent.

There was a freedom from recurrence for over a year in 37·5 of the cases of papilloma, as compared with an immunity for over a year in only 27·5 per cent. after supra-pubic operations without resection. It is hardly necessary to mention that recurrence may frequently occur after a year, but this does not spoil the value of the figures for the purpose of comparison.

The growth can be most readily resected when it is situated somewhere in the upper or middle zones of the bladder, whereas it is most difficult, and frequently impossible, to excise widely enough when the tumour arises from the region of the trigone without destroying one or both ureteral orifices or the sphincter vesicæ. Unfortunately all growths of the bladder are infinitely more common at or near the trigone than anywhere else. When it is necessary to remove a portion of one ureter the latter may be implanted into the reconstructed bladder, and in some cases both ureters may be so treated, as in Dr. Harris's patient (p. 605).

Where the vertex or neighbourhood is the seat of the growth Antal's **extra-peritonæal method** should be followed. By this a large amount of the upper part of the bladder may be removed, but the farther the resection is carried the greater is the difficulty of stripping off the peritonæum, and, of course, in closing the gap.

The peritonæum is much more easily peeled off when the bladder is full than when it is empty. The edges of the wound in the bladder should be closed with catgut sutures as completely as possible. When the resection has been so complete that the gap cannot be closed, its edges must be united to those of the parietal wound, and the opening closed later on by a plastic operation.

A good account of a case of resection of part of the lateral wall and disease of the bladder is given by Mr. H. Fenwick (*Clin. Soc. Trans.*, vol. xxvii. p. 164) :

The patient was a man aged 46. The growth, an epithelioma, had been removed twice before, the first time by the perinæal route, the second time supra-pubically, from a spot to the left of the orifice of the left ureter. "On opening the bladder supra-pubically the growth was found to have recurred in the scar of the previous

operation. It was now a smooth, sessile epithelioma, one inch and a half by one inch. The base was indurated, and the infiltration had involved the muscular and sub-mucous layers, for they were glued to the tumour. In order to gain free access to the left lateral wall of the bladder, I drew my knife horizontally through the left lower abdominal muscles, the incision commencing at the supra-pubic opening, and ending at a point above the inner third of Poupart's ligament. Stripping off the peritonæum from the front wall of the left pelvis, I kept it packed up with sponges. I then resected the growth by cutting away with scissors it and the entire thickness of that part of the bladder which was subjacent to it. The bladder incision commenced at the median opening, and passed directly to the left until the upper margin of the growth was reached. It then proceeded round the tumour. The left side of the trigone was almost involved, but the ureteral orifice was not encroached upon. The hæmorrhage was not severe, and was easily controlled by a couple of dozen Spencer Wells's forceps." The edges of the bladder wound were drawn together by catgut sutures which traversed only the muscular layers, a small supra-pubic opening being left for drainage. This wound and that in the abdominal wall healed quickly, and two years later (*Brit. Med. Journ.*, 1895, vol. ii. p. 907) Mr. Fenwick stated that the patient was at work in good health.

All will agree with the three conditions which Mr. Fenwick considers necessary before such operations are undertaken: (1) a single growth, slow and dense; (2) absence of cystitis; (3) sufficient vitality on the part of the patient to bear so serious an operation.

Dr. Malcolm Harris, of Chicago (*Ann. of Surg.*, 1902, p. 509), successfully resected the prostate and the greater part of the bladder extra-peritonæally in a man æt. 53 for carcinoma involving the trigone and invading the prostate. The upper end of the bladder was saved, and the ureters were implanted into it.

The operation was performed on Oct. 5, 1901. A long median supra-pubic incision was made, and the peritonæum displaced upwards. The sides and front of the bladder and prostate were cleared down to the base, and the urethra was divided just above the triangular ligament. Beginning from below, the prostate and the bladder were gradually separated from the rectum. "This, which was the most difficult part of the operation, was facilitated by an assistant introducing two fingers into the rectum, thus raising all the parts well forward. The hæmorrhage during this part of the operation, though considerable, was not as severe as was anticipated, and was materially lessened by keeping the bladder well drawn forward, that is toward the supra-pubic opening, as fast as it was separated from the rectum. The ureters, as soon as they came into view, were easily divided beyond the disease. The right ureter was considerably enlarged and tortuous, owing to the obstruction which the growth had produced at the ureteral opening. Some small enlarged lymph glands which were found in the connective tissue to the side of the bladder were removed. As the vertex of the bladder was not involved in the diseased process, a portion of it, six to seven centimetres in diameter, was retained. The remainder of the bladder and the prostate were removed. Small slits were made in the remnant of the bladder, and the ureteral ends drawn through and stitched with catgut. The small portion of the bladder was then stitched by its edge to the inner edge of the supra-pubic opening, except at the lower part. The cavity in the pelvis was packed with gauze, and a large rubber drainage tube inserted to the bottom of the cul-de-sac. The peritonæal cavity was not opened. Time of operation, about one hour and thirty minutes. There was considerable shock following the operation, but this was slowly recovered from, and in about two weeks the patient was able to sit up. The cavity filled in quite rapidly, and the tube was soon dispensed with. In about a month the patient had gained in strength so as to be up and around. The ureteral openings in the small practically exstrophied bladder were easily seen, and the urine escaping from them was clear, and on analysis normal, with the exception of a small amount of pus from the surrounding parts.

"On drawing the edges of the supra-pubic opening together the lower part of the small

bladder would dip slightly behind the upper edge of the symphysis pubis. A catheter introduced through the penis reached the small bladder, and nearly all the urine drained off through the catheter. It was, therefore, retained permanently in position." The man was going about and improving, when he developed lobar pneumonia and died early in December, 1901.

Dr. Harris was led to retain a portion of the bladder, with a view of its ultimate regeneration into a serviceable receptacle by noticing the remarkable way in which the base and a small part of the posterior wall of the bladder had enlarged in a man who had lost the upper and greater part of his bladder from sloughing as the indirect result of an accident. The man gradually regained the power of retaining his urine quite well.

The upper part of the bladder, however, is never likely to develop the power of retaining much urine, and this fact alone will militate against its enlargement. Still Dr. Harris's ingenious operation is capable of further development and modification.

Vaginal Resection of a Part of the Bladder.—In the female, when the growth is situated at or near the trigone as usual, the vaginal route is safer, and better for partial resection. A longitudinal incision is made in the anterior vaginal wall, and the growth resected; the bladder is reconstructed, and the vagina carefully sutured. The bladder must be drained by means of a soft catheter.

Intra-peritonæal Resection of a Part of the Bladder.—This may be necessary when the growth arises in or invades the postero-superior part of the bladder, where it is covered with peritonæum. It is not necessary to adopt such mutilating procedures as resection of a part of the symphysis pubis, as advised by Helferich; but the Trendelenburg posture, a large incision, and good retraction, give plenty of room and a good view.

A long median incision is made, and the bladder freely opened in front, the escaping liquid being carefully removed with gauze sponges. The peritonæal sac is then opened, and the field of operation carefully isolated with gauze tampons, which protect the intestines which have fallen away from the pelvis. If the growth extends at all near either ureter a bougie must be passed into this, as a guide during the subsequent steps. The part to be removed is taken away from within, a hand introduced into the peritonæal sac and behind the bladder, keeping touch of the catheterised ureter and guiding the scissors.

The wound in the bladder is then sewn up, beginning from the postero-inferior angle. Catgut is used for the suture which does not pierce the mucosa, and is reinforced by a Lembert or Cushing continuous suture for greater security. An oblique perforation is then made through the wall of the reconstructed bladder at the most accessible part for the ureter, which is drawn through the puncture by means of narrow-bladed forceps. The ureter should fit snugly in the oblique canal, which should be about an inch long. The part of the duct which now projects into the cavity of the bladder is slit for a short distance and sewn to the vesical mucosa with fine catgut. If possible one or two sutures should also be inserted to strengthen the point of junction with the bladder upon the peritonæal surface. A catheter is passed into the ureter and brought out through the supra-pubic drainage tube. The vesical wound is partly closed around the

tube, and the space between the bladder and the pubes is drained with gauze.

Complete Extirpation of the Bladder.*—This operation has been performed by Bardenheuer and Gussenbauer. The first successful case was by Pawlik, of Prague. Clado has had a second. Both of these were in women. In each case the operation was done in two stages, the ureters being first diverted to and secured in the vagina, and then, about three weeks later, the bladder removed. The vagina by the second operation was converted into a pseudo-bladder, the urine being voided through the urethra. Pawlik's patient was alive two years and a half after the operation, and in fair comfort. Drs. Tuffier and Dujarier (*Revue de Chirurgie*, April, 1898) described a successful case of complete extirpation of the bladder in a man in one operation, the ends of the ureters being implanted into the rectum. Two months after the operation the man was able to do his work. Dr. Watson has collected the records of 25 cases of total extirpation of the bladder for carcinoma, with 14 deaths, a mortality of 56 per cent.; out of the 11 that recovered, six, or 54·5 per cent., were known to be free of recurrence a year later.†

In some cases, in which the growth has not invaded the part of the bladder which is covered with peritonæum, it may be possible to perform the operation extra-peritonæally, but in the majority of patients in whom total extirpation is indicated at all the peritonæum must be opened, and most of the serous covering of the bladder sacrificed, in order to get well beyond the disease, and for the same reason the prostate should be removed with the bladder. Moreover, it is easier to do this than to leave it and have to deal with the comparatively broad pedicle formed by the base of the bladder.

The ureters have been diverted into the rectum, vagina, urethra, or brought to the skin. In the female the vagina is the best to choose, and in the male the rectum or sigmoid is on the whole the best, although there is more danger of ascending nephritis than with urethral and cutaneous implantation, but the control of the urine acquired by the rectum is a great advantage, and the ureters may not be long enough to join to the urethra. When the intestine is selected, the perforations should be made as obliquely as possible, and ureteral catheters fixed in and brought out at the anus, to prevent distension of the rectum before the union is complete.

The bladder may be separated either (a) *from above downwards* (Lund), or (b) *from below upwards* (Harris). The former method is most suitable when the peritonæum need not be opened, and it also has the advantage of allowing the surgeon to tie the larger blood-vessels and secure the ureters very early in the operation. The latter method has the advantage that the main part of the operation can be conducted extra-peritonæally in all cases, even when some of the serous coat has to be sacrificed.

* A paper by M. Chevalier (*Arch. Gén. de Méd.*, t. ii. 1894) contains much information on partial and complete resection of the bladder.

† Watson (*Ann. of Surg.*, vol. xlii. p. 805) gives a valuable table of the recorded cases of total extirpation for growth. Hartley (*Med. News*, Aug. 29, 1903) also collected and discussed 23 cases of total excision of the bladder for malignant growth.

(a) Mr. Herbert Lund (*Lancet*, 1902, vol. ii. p. 1624) removed the whole bladder for extensive papillomatous growth, but the patient died three days after the operation of pre-existing renal suppuration. The following excellent description of the operation is taken from the *Lancet*:

Operation.—The patient was placed “in the dorsal, and not in Trendelenburg’s, position. The bladder was washed out and then moderately distended with boric lotion. A vertical incision was made in the middle line about four inches long, and the recti muscles were separated but not divided either transversely or at their attachments into the pubes. Great care was taken not to open the peritonæal cavity. The bladder was then easily exposed and opened, and a digital examination was made. The growth was chiefly confined to the trigone and lower half of the bladder, the fundus being fairly free; some of the papillomata were long and branching. To the right of the fundus was a pouch. Mr. Lund at once determined to remove the whole bladder. Commencing at the fundus, the peritonæum was stripped off, and in doing this two small rents occurred, neither of them half an inch in length, and they were at once repaired with a continuous catgut suture. The stripping was tedious, but not difficult. Then working at each side alternately and clamping and ligaturing numerous fibrous attachments, the left ureter was exposed and divided close to the bladder, the cut renal end being for the time held in catch forceps. The bladder being now fairly free, it was easier to locate the right ureter, and after this was accomplished and dealt with the viscus was rapidly turned forwards and downwards until the upper border of the prostate came into view. Gentle dissection with the finger separated the rectum, and all that now remained was the neck of the bladder. After freeing it as close up as possible to the triangular ligament a stout silk ligature was passed round it, and the neck was divided. The hæmorrhage was never great, any vessel seen being divided between double ligatures.

“The ureters were next dealt with. Through each cut end a fine catgut ligature was passed and looped to facilitate subsequent drawing down into the rectum. A finger being passed per anum, sinus forceps were guided along it as far up the bowel as possible, probably about four inches, and were then made to perforate the bowel. In this way, by drawing upon the catgut ligatures, the ureters were pulled downwards through the perforation, and as far as could be judged about one inch of each ureter lay free in the rectum. No attempt was made to fix the ureters by suture to the rectum, but the transfixing ligatures, being brought out per anum, were tied round a large piece of rubber tubing. The operation had occupied two hours, and, in spite of skilful administration of chloroform and ether, the patient was much collapsed. A Keith’s tube was placed in the lower angle of the supra-pubic wound, and the cavity was lightly packed with iodoform gauze. No tube was used for draining the rectum. Mr. Lund thought that the urine would easily find its way out along the ligatures attached to the ureters, but in this he was mistaken.”

Urine accumulated in the rectum and leaked through the supra-pubic wound until a rectal tube was introduced on the second day. The patient died from suppurative nephritis and uræmia.

(b) The following is a modification of Dr. Harris's method of partial extirpation, in which he was able to leave the upper part of the bladder, where it was covered with peritonæum (*vide* p. 605).

Operation.—The bladder having been washed out as usual and distended with air, a long vertical or transverse incision is made above the pubes, exposing the bladder extra-peritonæally. The bladder is opened, and the exact extent of the disease determined, especially as regards the freedom or otherwise of the prostate. The interior is then cleansed, and a pack of gauze left within it for collecting the urine, which is usually septic, as it issues from the ureters.

The surgeon then separates the bladder from the pelvic wall by blunt dissection as far as the prostate, or if the latter is involved as far as the triangular ligament. This procedure is easily carried out on the anterior and lateral aspects, but difficulty will be experienced in separating the bladder and prostate from the rectum; and an assistant should pass two fingers into the rectum as guides. If the prostate is to be removed the urethra should be first divided just above the triangular ligament, as recommended by Dr. Harris. The separation of the prostate and bladder from the rectum can then be carried out far more easily by working from below upwards and backwards, the bladder being meanwhile pulled forwards and upwards as far as possible to provide a better view and to control hæmorrhage. The ureters are sought, clamped, and divided above or beyond the disease. The peritonæum is now opened above the bladder, the Trendelenburg posture adopted, and the field of operation carefully isolated by gauze packing. The peritonæal covering of the bladder is incised and separated from the bladder, but if any of it is involved or adherent, it should be excised with the bladder. The remaining flaps of peritonæum may be sewn together if possible after carefully drying the pelvis, in which a drain may be left. The ureters are then implanted into the vagina, rectum, or urethra. A drain is passed into the extraperitonæal space from which the bladder has been removed. The upper part of the parietal wound is then closed.

Causes of Death after Removal of Bladder Tumours.

1. Shock. Mr. R. Harrison (*Lancet*, 1884, vol. ii. p. 678) records a case of a man, aged 42, who died somewhat suddenly, apparently from shock, twelve hours after removal of a villous tumour by the perinæal method. The hæmorrhage, which had begun four years before, had for a year been persistent and considerable. Mr. Harrison, in illustration of the sudden and excessive bleeding to which villous tumours are liable, even when they appear comparatively quiescent, has published (*Liverpool Med.-Chir. Journ.*, July, 1884) a case where death took place from this cause in nine hours. In this instance slight hæmaturia had existed for some months previously, but no operation had been performed. Mr. Morton has drawn attention (*Lancet*, 1896, vol. i. p. 480) to the possibility of secondary hæmorrhage. In his case a papilloma had been removed supra-pubically, the pedicle being cut through with scissors. Severe bleeding took place on the third day, necessitating opening up the wound. The patient recovered.

2. Collapse from hæmorrhage before, during, or after the operation, or from exhaustion. 3. Uræmia is a very common cause, and may be secondary to pre-existing obstruction of one or both ureters, and the

superadded trauma of the operation, with or without sepsis. The anæsthetic also has a bad effect. Evidence of chronic or impending uræmia will of course be sought for before any operation is undertaken, the urine being thoroughly examined. 4. Ascending suppurative nephritis. 5. Cellulitis. 6. Injury to the bladder and peritonitis. Mr. Bryant (*Lancet*, 1886, vol. ii. p. 1077) mentioned a case in which a fibrous polypus was drawn from the fundus into the perinæal wound and snipped off. The man died of peritonitis, and a small hole was found in the bladder at the site of the removed polypus. 7. Recurrence. This may appear first in the cicatrix of the wound. 8. Abscess in the track of the apparently healed wound, bursting into the peritonæal sac (Sir H. Thompson, *Clin. Soc. Trans.*, vol. xxi. p. 46).

OPERATIVE INTERFERENCE IN TUBERCULAR DISEASE OF THE BLADDER.

It should be remembered that tuberculous cystitis is uncommon as a primary disease, and every effort should be made to discover a possible source in the kidney, epididymis, vesiculæ seminales, lungs, or elsewhere. A careful cystoscopic examination may show that the vesical disease is limited to the neighbourhood of one or other ureteral orifice, which may be itself dilated, ulcerated, or retracted, or discharge pus indicating disease of the corresponding kidney or ureter.

If the diagnosis is confirmed by a lumbar exploration, and the opposite kidney has been proved to be normal in function (p. 149), nephro-ureterectomy is indicated, and may be followed by complete and permanent recovery of the bladder.

It is not wise to use the cystoscope when the diagnosis is certain from the symptoms and from the presence of obvious tuberculous disease elsewhere, especially in the genito-urinary organs, for instrumentation of any kind is to be avoided as far as possible.

My own experience in several of these cases and a study of what others have published leave me strongly of opinion that operative interference in the form of cystotomy is rarely justifiable here. My reason for this opinion will be gathered from the following **Indications and Cautions**. (i) It is an accepted fact by all careful surgeons that in tubercular affections in which it is not possible to remove the mischief operative interference may do more harm than good. Under such conditions the manipulations only irritate early tubercle into activity, and light up again obsolete or quiescent tubercle, besides causing certain dangers* peculiar to this viscus—viz., cystitis and pyelitis. Again, to show how useless and even harmful will be operative interference in the early stage of tubercular mischief, a stage in which alone can such treatment be expected to be curative, let us consider what are the conditions present at this early stage. To put it briefly, it is not one suitable for curetting, &c., as is often the case

* Another ill result which is very possible here is rupture by even a moderately dis-tending injection of a contracted, rigid bladder the seat of long-standing tubercular mischief, and one emptied for some time by irritability and incontinence. I would refer my readers to two such cases candidly published by Mr. H. Fenwick in his instructive book *Cardinal Symptoms of Urinary Diseases*, p. 200.

with tubercular mischief elsewhere.* The mucous membrane is swollen, very vascular, velvety, at times gelatinous. Any ulcers present are often small, even minute and numerous, so that it is impossible to make sure of efficient curetting, especially when anyone familiar with the interior of the bladder knows how quickly a little bleeding hides the field of operation, and the fact that the mischief is usually most marked on the posterior wall, trigone, and neck. The following is a good description of a condition often present in these cases †: "The trigone and a band of about an inch in depth around the urethral orifice were the seat of many superficial ulcers, varying in size from that of a split pea to irregular patches as large as a five-cent piece. The mucous membrane of the whole fundus of the bladder was also studded with small tubercles which had not advanced to the stage of ulceration nor, indeed, even to the length of showing signs of caseation. The ulcerated patches were scraped and cauterised, but the little non-ulcerated tubercles were left untouched. They were so numerous that it would have been impossible to deal with each one singly." Mr. Battle's case (*Clin. Soc. Trans.*, vol. xxiii. p. 201), which was greatly benefited by scraping after other treatment had failed, owes its success largely to the condition found, which was, I think, a very rare one. The ulcerated surface was single, though very extensive, spreading over the left lateral and posterior wall, from the trigone almost to the summit, with the bladder relaxed. After the ulcer had been scraped it was dabbed over with a solution of chloride of zinc (30 gr. to 3j). The patient was seen nearly a year later, soundly healed and able to hold her water for three hours at a time. It is not stated whether pyrexia was then present. (ii) For these reasons I am strongly of opinion that in the earlier stages we should treat tubercular disease of the bladder not by operation,‡ but by improving the hygienic surroundings, especially, whenever it is possible, getting the patient to be much in the open air, if possible by the sea. Injections of Koch's new tuberculin promise to be of considerable value in suitable cases, although it is not claimed that a cure may be obtained from its use. It should not be resorted to unless the disease is limited to the bladder, and except after the tubercle bacilli have been found in the urine. It relieves the pain, diminishes the frequency of micturition and the hæmorrhage. In some patients, however, the symptoms have been aggravated by the injections (Fenwick, Wright, and others, *Lancet*, 1904, vol. i. p. 935). This method is certainly worthy of a thorough trial with the precautions and restrictions mentioned. Intra-vesical injections of iodoform emulsion, solutions of perchloride of mercury,

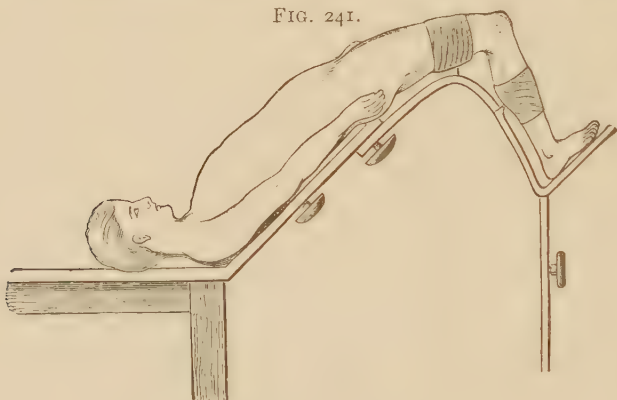
* Prof. Guyon reported (*Ann. des Malad. des Voies Urin.*, November, 1889) very fully four cases which he treated by curetting and the cautery after a supra-pubic cystotomy. One of the four died two years after the operation, the patient having a persistent sinus and being bedridden most of the time. One died within the year, and one within about three months of the operation. The fourth had survived four years.

† J. Bell, M.D., of Montreal, "Treatment of Tuberculosis of the Bladder by a Supra-pubic Section," *Journ. Cutan. and Genit. Urin. Dis.*, 1892, p. 298.

‡ Dr. L. Bolton Bangs, of New York, whose experience in diseases of the genito-urinary organs is a very wide one, thus expresses himself on this matter: "After faithful and zealous efforts to relieve by surgical interference the local symptoms of these cases, I have been forced to the conclusion that the less instrumentation we resort to the better."

chloride of zinc, or nitrate of silver, are disappointing and troublesome, and may aggravate the disease. Internal administration of urinary antiseptics, such as urotropine, helmitol, and others, is useless. (iii) The cases that call for operative interference are those in which what I may be allowed to call hygienic treatment has failed, or in which the case has got beyond this, where pain is incessant, micturition frequent—*e.g.*, every half-hour day and night—with much tenesmus, and where opiates are required to afford sleep. There should be no advanced disease present of the other urino-genital organs, kidneys, lungs, &c. If a single ulcer is discovered by cystoscopic examination, it may be excised in some cases, although this is not an easy matter, for the solitary ulcer is nearly always situated at the trigone. (iv) The supra-pubic operation is always to be preferred. The perineal gives very little room, and, moreover, has the great drawback that a tube thus introduced will very likely press upon the neck or trigone, parts very liable to be attacked by tubercle. Again, this opening has a great

FIG. 241.



Trendelenburg's position. (R. Harrison.)

tendency to close before the full benefit of drainage has been secured; but I have seen several patients considerably relieved by perineal drainage. The vaginal opening seems to me to be liable to the same objection as the perineal—*viz.*, that the vesical end of a tube thus introduced is very likely to rest against an ulcerated surface. (v) The tube should, if possible, be withdrawn in about three weeks, and, as soon as the wound is closed, every effort should again be made to place the patient under the best hygienic surroundings, to the necessity of which I have alluded above. Hospital patients should be got into better air at once. But too often the after-treatment of supra-pubic cystotomy for tubercular cystitis resolves itself into the following dilemma. If the opening is closed all the pain, &c., soon recurs; if it is kept open there is much difficulty in preventing noisome soaking. A tube and plug worn in the supra-pubic sinus rarely acts well in these cases, where the bladder is often small, contracted, and thick-walled. Mr. Colt's supra-pubic drainage apparatus is the most efficient means of keeping the patient dry (*vide* p. 602). (vi) The patient may enjoy years of fairly active and happy life after a supra-pubic cystotomy, if the opening has closed within a reasonable time of the operation, but

he will be liable to other outbreaks of tubercular mischief secondary to disease which was probably present, though quiescent, at the time of the cystotomy—*e.g.*, tubercular testis and kidney.

When the disease is secondary to unilateral renal tuberculosis, or to a tuberculous testis, nephrectomy or orchidectomy may be followed by a gradual cure of the secondary disease in the bladder (*vide* pp. 195).

Operation.—The details of a supra-pubic cystotomy are so fully given at pp. 622—624, that it is needless to repeat them here. I will only add the caution that great care must be taken in distending these bladders. Four to six ounces will be as much as can usually be injected with safety. The bladder is first opened, and its interior exposed with some suitable speculum (p. 596), aided, if needful, by the Trendelenburg position (Fig. 241). A single ulcer may be excised in some cases. Any ulcers should be carefully and thoroughly curetted or cauterised with a fine point of the Paquelin's thermo-cautery, iodoform rubbed over the surface or left in, in the shape of the emulsion. To any very vascular, gelatinous-looking mucous membrane, not ulcerated, a solution of AgNO_3 3ij—3j* should be applied on a small sponge on a holder.

The following is a good instance of the relief which supra-pubic cystotomy may give in a very obscure case:—

In May, 1890, I was asked by Dr. Cock and Dr. Hodgson, of Exmouth, to explore the bladder of a gentleman, aged 57, suffering from painful cystitis, hæmaturia, and frequent micturition, to which general treatment, washing out the bladder and drainage by a catheter, had failed to give any relief. Calculus being excluded by sounding, and there being no rectal enlargement of the prostate, I expected to find a small malignant growth, as the symptoms were too urgent for prostate trouble, and as this gland was not enlarged either to the finger or the sound. The bladder, having been opened and emptied by the supra-pubic method, at first appeared normal save for some subacutely inflamed rugæ which stood out very distinctly on the right lateral aspect of the neck of the bladder. A small electric lamp at once showed amongst these folds two ulcers each about one inch by a quarter of an inch, oval in shape, with muscular fibre clearly exposed on their floors, their edges neither thickened nor indurated. They were scraped with a sharp spoon, and iodoform was then rubbed into their surfaces. The patient made an excellent recovery, and now, six years later, remains quite well. In this patient, with a deep, fat perinaeum, I should never have detected the ulcers by the perineal route.

If the operation is performed with the object of securing long-continued drainage, only a small incision is made into the bladder, and the edges of this are carefully sutured to the skin, so that the fistula may not close so readily. In some intractable cases with painful micturition extirpation of the bladder, with transplantation of ureters into the rectum or sigmoid colon, may be considered.

Hartley (*loc. supra cit.*) has removed the whole bladder for tuberculous disease; he joined the ureters with a part of the bladder to the sigmoid colon. The operation gave great relief, and the patient was well and working as a clerk nine months later. She voided urine about three times during the day and once or twice in the night. Total extirpation can be rarely indicated for tuberculosis, and should not be contemplated until hygienic treatment and injections of tuberculin have been well tried (*vide* p. 607.)

* This may appear strong, but it gives very marked relief. In women it may be applied at repeated intervals after dilatation of the urethra. If it should give much pain, which, in my experience, it rarely does, a solution of sodium chloride may be injected.

LATERAL LITHOTOMY (Figs. 160, 161, 162).

Owing to the introduction and perfection of the crushing operation for stone, lateral lithotomy is now seldom called for. The chief indications are—(1) In children, when the stone is a small one, and when the surgeon is inexperienced in the use of the lithotrite, it is the operation of choice. (*Vide* also the remarks on pp. 646—648.) (2) In the case of a large stone with which it has been decided to deal by perinæal lithotritry (p. 645) the bladder is opened by the same steps as in lateral lithotomy. (3) In certain cases of stricture of the urethra and enlarged prostate, where a staff can be passed. In the majority of the cases of enlarged prostate, however, the supra-pubic method is to be preferred, as by this means the prostatic hypertrophy can be more readily dealt with at the same time, and the bladder more thoroughly examined, especially as regards the presence or absence of diverticula which may contain stones (p. 621).

The lateral operation will be described under the following heads :

A. Preparatory Treatment.**B. Passing the Staff. Possible Difficulties.****C. Finding the Stone. Possible Difficulties.****D. Entering the Bladder. Possible Difficulties.****E. Extracting the Stone. Possible Difficulties.**

A. Preparatory Treatment.—For a week or so before the operation the diet should be bland, so as to tax as little as possible jaded kidneys—*e.g.*, milk, barley-water, light puddings, and a little fish. If alcohol is needed, some sound spirit, well diluted, should be given. Baths should be taken regularly, the bowels well moved, and an enema given on the morning of the operation, and care should be taken that all this has come away.

B. Passing the Staff.—This step, however simple and easy usually, presents occasional difficulties, the more trying because perhaps unlooked for; they are—

(1) Spasm, from the urethra not being used to instruments; (2) stricture; (3) a false passage; (4) an enlarged prostate; (5) an enlarged prostatic sinus, into which the end of the sound passes. Mr. Buckston Browne's staff meets the last two admirably.

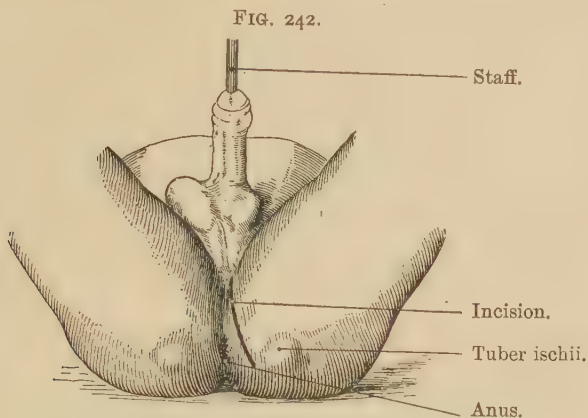
C. Finding the Stone with Sound or Staff. Possible Difficulties.

(1) The stone may have been passed.* This is not impossible in children with small, smooth, narrow calculi, and their sudden, strenuous micturition. (2) The stone may lie behind an enlarged prostate. Here the finger of an assistant passed into the rectum may help. (3) The stone may be enveloped in folds of mucous membrane. Injection of the bladder is here indicated. (4) The stone may be encysted. This is so rare as to have been called "The refuge of young lithotomists." The following case of Sir G. Humphry (*Some Cases of Operation*, pamphlet, 1856) shows well how embarrassing this condition may be :

A man, aged 51, was cut, then submitted twice to lithotritry, then again cut in the old scar three times, all within six years, for an encysted calculus. On the fourth

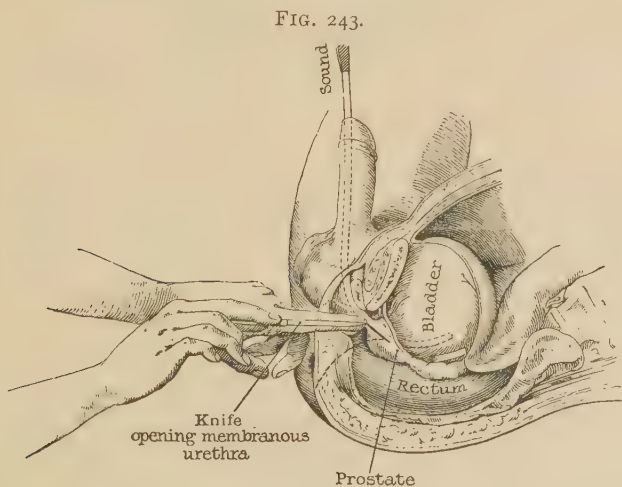
* *Cf.* the case mentioned by Mr. Holmes, *Clin. Soc. Trans.*, vol. ii. p. 67.

occasion of lateral lithotomy the nature of the case was made out accurately. The stone was now felt behind the prostate attached to the bladder by a pedicle which seemed to penetrate the coats of the viscus, and to be attached to another mass beyond it. It was evidently a stone of hour-glass shape, part being in the bladder and part in the sac. At each of the previous operations the part within the bladder had



Lateral lithotomy. (After Fergusson.)

broken off, the rest not being extracted, owing to the size of the prostate. The symptoms recurring, urethro-rectal lithotomy was performed. The stone being now within reach, the edge of the mucous membrane around it was incised with a hernia knife, and a stone the size of a walnut, and with a truncated stalk, extracted. Death



Lateral lithotomy. (After Fergusson.)

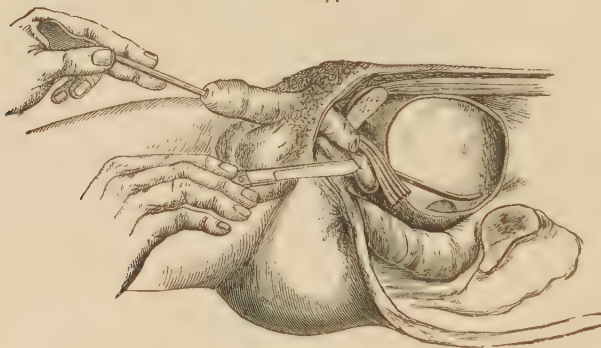
took place in two days, from pelvic cellulitis. Though the bladder was otherwise but little diseased, the cyst seemed to have originated from the protrusion of mucous membrane between the muscular fibres, as another one existed, though without a stone. The cyst communicated by a considerable opening with the foul, infiltrated tissues. Sir George points out that these cysts may be quite out of reach in lateral lithotomy. As their walls consist only of cellular tissue, mucous membrane, and

perhaps a thin layer of muscular fibre, they are easily lacerated during an operation, an accident almost certain to be fatal. The diagnosis is usually to be made if the stone is always struck by the sound at one spot, especially if, per rectum, a lump is detected corresponding to that spot.* The supra-pubic operation is indicated here. See footnote, p. 621.

D. Entering the Bladder.—The time chosen for introducing the staff varies with different operators. Passing the staff while the patient is still recumbent is the easier; passing it when the patient is in lithotomy position is rather more difficult, but secures the operator against the risk of the staff slipping out after the patient is brought down into position, a risk which is greater with the straight staff. I prefer to bring the patient's lower limbs over the edge of the table, to pass the straight staff while he is recumbent, and then to have his limbs only brought up into position.

The nates just projecting over the edge of the table, the sacrum being

FIG. 244.



Lateral lithotomy with a straight staff. (Key.)

flat upon it, the flexed thighs and legs being held well out of the way, the surgeon, seated comfortably, and with his face on a level with the perinæum, directs an assistant so to hold the staff as to bring the membranous urethra close to the surface of the perinæum. If a curved staff be used, this is easily done by inclining the handle strongly towards the abdomen. By this manœuvre, in Mr. Cadge's words (*loc. supra cit.*), the point of the staff "need not, and should not, be withdrawn from the bladder, but if it were it would be of no moment, because it would re-enter it the moment the handle is raised; the membranous urethra, instead of being almost perpendicular to the surface of the perinæum, as it is when the staff is held upright, is brought almost parallel with it, and is much easier to find with the knife; there is no inducement to open the urethra too far forwards, and consequently no risk of wounding the bulb or its artery. The staff gets a steady rest against the front of the pubes, and there is no danger to the rectum at

* Sir J. E. Erichsen (*Surgery*, vol. ii. p. 945) adds that the beak cannot be made to pass round such a stone so as to isolate it. To several other allied conditions of complicated stone see the reference at p. 634.

this stage." It thus combines the advantages of the two very different methods usually given—viz., either to hold the staff well up firmly under the pubes and thus away from the bowel, but also away from the stone, or closely down upon the latter and in proximity to the rectum also.

Having felt the staff thus presented towards him, having examined into the depth of the ischio-rectal fossa, the site of the tuber and ramus ischii, the surgeon, pressing up the junction of the scrotum and raphé so as to make tense the parts just about to be cut, enters his knife from a quarter of an inch to one inch and a half from the anus, just to the left of the raphé, and very likely hits the groove at once. The knife is then drawn outwards and backwards with a rapid sawing movement to a point midway between the anus and tuber ischii, thus making an incision of two or three inches, according to the age of the patient and size of the stone. Again inserting the knife into the upper angle of the wound, the surgeon makes out exactly with his left index finger the groove in the staff, and exposes this, beyond doubt, in the wound. The next steps differ somewhat accordingly as the curved or straight staff is used; they will be given separately.

(a) **With the Curved Staff.**—When the knife's point is felt firmly lodged in the groove, its handle is a little depressed; the blade, at the same time, turned a little to the left, is pushed steadily along the groove till a gush of urine or a sense of resistance ceasing, or both together usually, announce that the neck of the bladder has been sufficiently divided with the knife. The finger is now wormed into the bladder over the concavity of the staff.

(b) **With the Straight Staff.**—When the point of the knife is felt to be safely lodged in the groove, the surgeon takes the handle of the straight staff from his assistant, brings it down, and still keeping his knife in the groove, lateralises the staff slightly to the left. The handle of the knife being now depressed so as to form a sufficient angle with it, and make an adequate wound, the surgeon runs it along the groove steadily, till he knows by the above-given evidence that the neck of the bladder has been sufficiently cut.

The left index finger is next wormed over the edge of the staff, the straight staff being held by the surgeon himself in his right hand, the curved one being held by an assistant, till he feels that he has entered the bladder and placed the finger tip, if possible, in contact with the stone. Entrance into the bladder is known by feeling the finger surrounded with a smooth cavity lined with mucous membrane, while the finger itself is girt by a fibrous ring. The stone being felt, or the bladder cavity distinctly gained, the staff is withdrawn, and the surgeon, while taking his lithotomy forceps, dilates the opening into the bladder with his finger, which, at the same time, pulls down and steadies the neck.

Failure to enter the Bladder.—This most vexatious and embarrassing difficulty is most likely to be met with under two widely different conditions: (1) most frequently in little children; (2) in old patients with a very fat, deep perinæum and enlarged prostate. The first must be considered separately.

(1) *In Little Children.*—The causes here are the small size, delicacy, and mobility of the neck of the bladder and urethra, and the fact that

the bladder lies high up above the pelvis. Mr. Cadge quotes the following from Sir W. Fergusson :

"The point of the finger was, as usual, placed on the staff and pushed gently towards the bladder. The finger went on, but I was aware that it had not got between the urethra and the staff. With an insinuating movement (much to be appreciated by the lithotomist who, as I do, professedly makes a small incision in this locality), I endeavoured to get its point, as usual, into the urethra and neck of the bladder. But here I felt convinced that I had failed, and was aware that the finger was getting deeper as regards the depth of the perinæum, but that I was not materially nearer the bladder. I could feel a considerable space at the point of the finger, and was convinced that the upper part of the membranous urethra, as well as the sides, had given way to the pressure, and that now, as the finger was getting deeper into the wound, I was only pushing the prostate and neck of the bladder inwards and upwards. These parts seemed to recede before the smallest imaginable force, whilst I felt that I could, in a manner, make any amount of space around the bare part of the staff. I had no difficulty in distinguishing between the surface of this space and that of the mucous membrane of the bladder. Moreover, I knew that I had never crossed that narrow neck which is always felt as the finger passes into the bladder when a limited incision is made. An impression came over me that I was about to fail in getting into the bladder, and I had an idea that, unless I could open the urethra in front of the prostate more freely, I should probably never reach the stone. This I effected with great caution, and then I could appreciate the passage of the finger as usual through the neck of the bladder. The stone was easily touched and removed, but I was forcibly impressed with the idea that I had nearly failed in the performance of the operation." The child here was four years old.

Mr. Cadge thus met the same difficulty in an infant of one year and a half :

"I felt the impossibility, even with a fair incision, of distending the wound with my finger ; it was like trying to get into the orifice of the urethra. I therefore desisted before doing any harm, and, taking a pair of common dressing-forceps, I passed them easily along the staff into the bladder ; by opening the blades gently but firmly, room was gained, and the finger entered and made room for small lithotomy forceps. But I have repeatedly, after passing the dressing-forceps, withdrawn the staff and removed the stone with them, and without introducing the finger at all."

Difficulties and Mistakes during this Stage of entering the Bladder.—This is so important a part of the operation that the following may be enumerated here :

(1) Finding the staff. This is not likely to present difficulties in the case of a curved staff if it be held as advised at p. 616. Hitting a straight staff in a fat child is not always easy, owing to the small size which is needful. Attention must be paid to entering the knife at the root of the scrotum only just to the left of the raphé, when the finger-nail will detect the staff at once. (2) Not exposing the staff. Everything which lies over the staff in the upper angle of the wound must be clean-cut. The tissues here, including the membranous urethra, are lax and delicate, and, unless the knife is clearly in contact with metal, the groove will not be followed. (3) Losing the groove. This most serious accident may be due to not getting the knife cleanly into the groove, not keeping it sufficiently firmly in contact with it, and, thirdly, by forgetting to depress slightly the handle of the knife. (4) Cutting the prostate too freely as the knife is brought out. This can easily be avoided by keeping the knife sufficiently near to the staff. (5) Cutting into the rectum. This may be due to neglect of the following precautions : (i.) keeping the staff up away from the bowel ; (ii.) guarding

the bowel with the left forefinger in the wound; (iii.) when the knife is lateralised, cutting away from the gut. Mr. Cadge (*loc. supra cit.*) points out that the usual place of puncture is the dilated part just above the internal sphincter, and that this communication may be made secondarily by sloughing after extraction of a large stone, or after the use of a plug for arresting hæmorrhage. His experience is that "nature seldom fails to bring about a cure, or so to contract the wound as to leave but trifling inconvenience." (6). Wounding the posterior wall of bladder.

Sir S. Wells, at the discussion of Sir H. Thompson's paper (Med.-Chir. Soc., April 2, 1878), mentioned a case in which Mr. Tyrrell wounded the back of the bladder, and hence always advocated a short knife. That this accident happened even in the hands of Aston Key himself I know through the father of an old Guy's man who was present at the time.

E. Finding and Extracting the Stone.—The surgeon's left index finger, having passed into the bladder along the concavity of the staff,* finds the stone, hooks this down as near to the neck as possible, and at the same time steadies the neck while it dilates the incision in it and in the prostate. This combination of movements requires most careful attention to each of its details separately. The most important of these is the dilatation of the neck and prostate. If the stone is found to be a large one, the deep part of the wound must be sufficiently free. It is well known how much has been written on this matter. The surgeon should begin by dilating the neck of the bladder carefully and equally in every direction, using a considerable amount of force in an adult, but not throwing this on any limited portion of the wound. It may be accepted as a certain fact that the wound in the prostate may extend through the whole of this body, without risk of cellulitis, if only the recto-vesical sheath is not torn through. As long as the finger is girt by a fibrous ring this mischief has not been done. Whether an extensive wound in the prostate had better be made by dilatation and laceration or by free incision will probably never be settled. The wise surgeon will avail himself of a safe use of both—that is to say, after dilating with forcible but equal pressure all around the original wound in the neck, he will introduce a blunt-pointed narrow-bladed bistoury flat against the pulp of his finger, and nick the remaining constriction at one or two places, then dilating again.

Next, as to the size of the stone, the age of the patient must here be considered. After middle life the cellular tissue around the neck of the bladder is not only loose, but abounds in enlarged veins. Hence the risk of causing not only cellulitis, but septic phlebitis, by dilating an inadequate opening by the tearing, bruising exit of the stone instead of by the finger and knife combined.

The deep opening having been thus made sufficiently free, the surgeon, having selected his forceps, introduces them along the finger (thus further dilating the wound), the latter being withdrawn as the forceps enter. These, held at first in one hand (the thumb in the ring), are fully introduced closed, then opened widely transversely, and, by a quarter-turn of the handles, the lower blade is made to scoop or sweep

* This is only withdrawn when the stone is felt, not before.

along the floor of the bladder, which will almost surely catch the stone. If this step fail, it is repeated, and if the stone is still not caught, the surgeon feels again for the stone either with the closed forceps or by again inserting his finger, which will bring down the stone, push off projecting folds of mucous membrane, &c. Differently curved forceps, supra-pubic pressure, and a finger in the rectum, may all help now.

The stone being caught, the finger again feels if it is held in its shorter axis; if so, it may at once be extracted, if moderate in size, by steady deliberate traction downwards and outwards. As long as the stone advances all is well; if not, gentle rotation may again start it on its way. In less easy cases Mr. Cadge's words should be remembered: "Should there be much resistance and no sense of gradual yielding, the surgeon will ask himself whether this is due to an insufficient opening, or to the projection of the ends of an oval stone laterally beyond the bladder. This latter may be known by observing that the bladder is brought bodily down, so that the prostate, which is probably large, is visible near the external wound; in this case the stone must be liberated, the finger again introduced, and a fresh hold taken. If the obstruction is due to a large stone and too small a wound, the latter is to be enlarged in the direction of the first incision; this, in the opinion of the writer, is preferable to making the division of the neck of the bladder on the opposite side, and preferable, too, to using undue traction and force."

In some cases a scoop will facilitate extraction, the stone being firmly held between the pulp of the left index finger and the concavity of the scoop. In children one finger in the rectum and one in the bladder will often serve the purpose.

The stone being out, the bladder is carefully explored with the finger, or a short-beaked staff, aided by pressure above the pubes, or from within the bowel, for any other calculi or fragments. Multiple calculi will have been indicated by facets upon the first.

Any bleeding vessels are now secured, a tube introduced, dressings applied, and the patient removed to bed.

Difficulties during the Stage of Extraction of the Stone.

(1) The position of the stone. This may be out of reach owing to its being at the posterior part of a dilated bladder, above the pubes, or to the patient having a very fat and deep perinaeum. Pressure above the pubes and the use of long forceps are here indicated. (2) An enlarged prostate. This interferes with reaching the stone both with fingers and forceps. Curved forceps passed in along the staff, or a gorget, if the perinaeum be very deep, will be helpful here. An enlarged middle lobe of the prostate, or a separate adenoma of this gland, may also cause trouble by getting between the blades of the forceps. Tearing away of these portions of the gland has often occurred, and was sometimes certainly beneficial. When the prostate is known to be considerably enlarged, it is far better to adopt the supra-pubic route, for this gives better access, and allows the surgeon to examine the bladder thoroughly, so that he may not overlook a stone behind the prostate or an encysted one (p. 637). In suitable cases, with but little cystitis, the prostate may be enucleated immediately after the removal of the stones. In others, with much cystitis, or interference with the renal function, it is better to be content with

lithotomy only at first, and to remove the prostate at a secondary operation, when the cystitis and the excretion of urea have improved as a result of drainage, &c. The mere removal of the stone is not enough, for the obstruction due to the enlargement of the prostate is usually the cause of the calculous formation. Perineal prostatectomy is not so satisfactory as the supra-pubic operation when a stone is present, although small calculi can be extracted after removing the prostate through the perinæum. (3) Breaking up of the stone. This may occur with hard calculi from too much force being used with the forceps, but it much more often happens with soft phosphatic calculi. In such cases every fragment must be cleared out—a matter of some difficulty, as small ones are readily concealed in clots or folds of mucous membrane. After all the larger ones are picked out a catheter of appropriate size, attached to a Higginson's syringe, is inserted, and the bladder thoroughly and forcibly washed out with diluted Thompson's fluid (one in six or eight, p. 623), or mercury perchloride one in 4,000. In a week or ten days the bladder should again be carefully sounded, and examined with the finger, and any fragment extracted, this being especially needful if pain has persisted after the operation.* If fragments still persist a little later, an evacuating-tube and washing-bottle, aided if necessary by a flat-bladed lithotrite, must be employed. I may here express my belief that multiple calculi are not quite as rare as has been supposed. (4) Size and shape of the stone. Mr. Erichsen writes on this subject: "A calculus, about an inch and a half in its shorter diameter, will be hard to extract through an incision of the ordinary length (not exceeding eight lines) in the prostate, even though this be considerably dilated by the pressure of the fingers; and I think it may be safely said that a calculus two inches and upwards in diameter can scarcely be removed by the ordinary lateral operation with any degree of force that it is safe to employ." Most will agree with Mr. Cadge that stones weighing upwards of 3 oz. will be dealt with by the improved supra-pubic method. Mr. Jacobson performed this operation twenty-six times, with only one death, which occurred in an aged very emaciated man with advanced kidney disease. The patient was in great suffering, and death would have been probable after any operation. Mr. Jacobson regards lateral lithotomy as a very safe operation (*vide* p. 647, footnote), and still advocates it for children, and writes: "I do not believe in the frequency of after-sterilisation, of which a few cases used to be reported from time to time. If this be a *causa vera*, I believe the risk to be less than that of the supra-pubic operation in ordinary hands."

SUPRA-PUBIC LITHOTOMY (Figs. 163—166).

Indications.—The surgeon who has the opportunity of becoming an adept in the use of the lithotrite, both through the meatus and through a perinæal wound (p. 645), will seldom have occasion to

* Recurrence of stone within two years almost always means that a fragment has been left after the operation. No greater disappointment than this, both to the surgeon and patient, can happen. No one, probably, has cut fifty patients without having to admit and lament its occurrence, but it is especially liable to occur to the inexperienced (Cadge).

perform supra-pubic lithotomy. Where, however, there has been no such opportunity, this operation will be required for the following conditions. These I quote from the concluding portion of a paper which I read before the Royal Medico-Chirurgical Society (*Trans.*, vol. lxix. p. 377).

(1) "That supra-pubic lithotomy, as recently modified, has a future of renewed usefulness before it, and that while, as an operation, it can never contrast with the rapid brilliancy of the lateral operation, it will be found of great value by those who only have to deal with stone occasionally, and by those who find themselves face to face with calculi of considerable size in adults. (2) That, to give other and more individual instances, the operation will be found useful (a) in many cases of hard stones of an inch and a half in diameter; (b) in multiple hard stones; (c) in some cases of foreign body in the bladder with abundant calculous deposit (Sir H. Thompson); (d) in cases of encysted stone.* (e) In the rarer cases of a state of urethra which will not admit the use of a lithotrite or a grooved staff. . . ." To these should be added, (f) in cases where the stone is associated with enlarged prostate (p. 635). The supra-pubic opening will here be convenient for removing the prostate as well as the stone, and also for thoroughly examining the interior of the bladder and removing all the calculi with certainty. The calculus is generally secondary to the prostatic enlargement, so that it is necessary to remove the prostate to give complete and permanent relief. The prostate may be enucleated either at the same sitting or later if there is much cystitis, or the renal excretion is seriously lessened. Free drainage and the removal of the stone may be followed by great improvement, and a secondary prostatectomy then undertaken successfully. (g) In cases of sacculation of the bladder, or where a stone has been seen through the cystoscope to be impacted at the ureteral orifice with a projection into the bladder.

The greater trouble and the longer time which this operation entails, both during its performance and afterwards, will not be grudged in these days, when it is so much the rule to pay attention to the details of surgery. Only time and a larger collection of cases will show how far, with much simpler structures to cut, with these brought safely into reach, and with modern antiseptic details at hand in the after-treatment, this lithotomy is safer than the far more brilliant lateral one.

Preparations.—Cystitis must be treated as far as possible by rest and by irrigation of the bladder for some days before the operation, and by the administration of such urinary antiseptics as urotropine, helmitol, boracic acid, benzoate of ammonium, &c. Urinary excretion may be promoted by copious libations and by diuretics. The bowels should be kept well open, and the rectum thoroughly washed out on the morning of the day of the operation. The pubis should be shaved and the abdomen cleansed and compressed overnight. Distension of the rectum with a rectal bag is not recommended, for its utility is doubtful, except in certain special cases in which it is desirable to raise

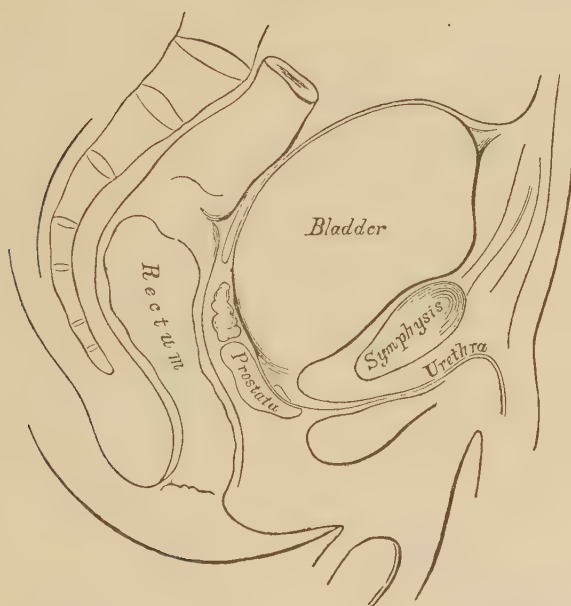
* Much useful information may be gathered from a paper by Mr. Bruce Clarke (*Brit. Med. Journ.*, May 13, 1899), in which an account is given of 27 cases of encysted vesical calculus.

the base of the bladder and bring it as much within reach as possible, *e.g.*, in operations for tuberculous disease, and for the removal of tumours from the base of the bladder. For the effect of rectal distension is chiefly to raise the bladder bodily in a direction upwards and forwards, and hence after incision to make the base more prominent and easier to reach; the effect as regards the supra-vesical fold of peritonæum is, on the other hand, so small that it may be neglected. Moreover, the procedure is not without danger.

Details of the Operation.

A. **Distension of the Bladder.**—Either water or air may be used for this purpose after the bladder has been thoroughly washed out, the

FIG. 245.



Sagittal median frozen section through the pelvis of a young man, the bladder being distended. (C. Langer.)

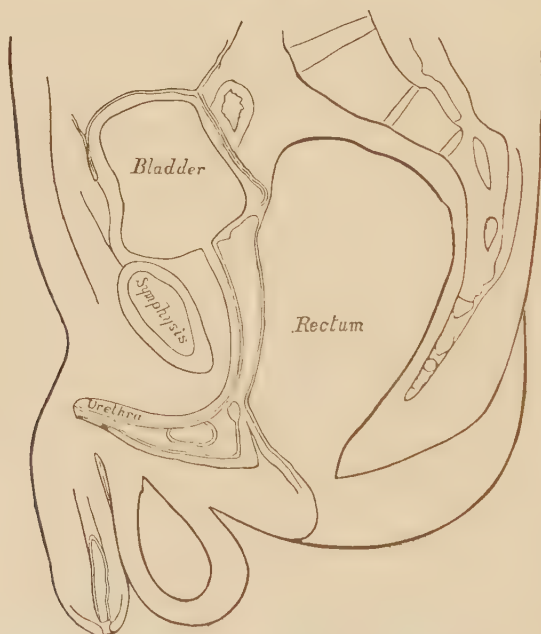
chief advantages claimed for air being (1) that its buoyancy tends to raise the bladder up to the surface, whereas the weight of water tends to drag it downwards towards the pelvis; (2) being compressible, it is less liable to do damage when the bladder walls are contracted and rigid; (3) there is no flooding of the wound when the bladder is incised, and therefore less liability of infection of the peri-vesical cellular tissue.

The air may be conveniently introduced by means of a bicycle pump attached to the catheter by means of a length of rubber tubing, no measurement of the quantity used being necessary when the plan advised below is adopted.

If distension with water is preferred to air, either Thompson's fluid (borax, 1 pint.; glycerine, 2 pints; water, 2 pints) diluted one in six, carbolic acid one in eighty, or perchloride of mercury one in 4,000, may

be used. This should be introduced by means of an irrigator raised about a foot above the level of the patient's abdomen. In this way a safety-valve is provided against any sudden rise of pressure within the bladder if any straining takes place. If the plan advised below is adopted it is not necessary to measure the quantity of liquid, but if it is preferred to introduce this first it must be measured, in this case 8 to 10 oz. for an adult, and a smaller amount for a child will be found to suffice; larger quantities should not be used for fear of causing damage from over-distension. The safest plan is to carry out the distension of the bladder after the incision has been carried down to the transversalis fascia and the wound well retracted, as advised by Tilden

FIG. 246.



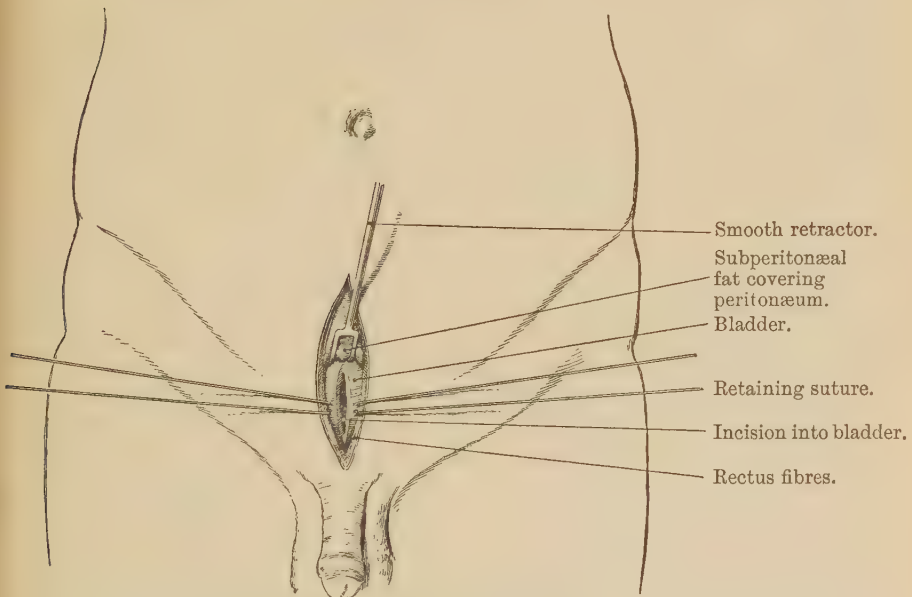
Sagittal median frozen section of male pelvis, with distension of bladder and rectum. (Garson.)

Brown (*Ann. of Surg.*, vol. xxv. p. 141). The air or antiseptic solution can then be gently and slowly introduced, and its effect gauged by the eye and the finger placed on the bladder. In this way the supra-vesical fold of the peritonæum may be raised to the desired extent without the slightest risk of causing damage from over-distension.

B. The Operation Itself.—The pubes having been cleansed, the knees slightly flexed, and the shoulders a little raised, an incision is made about three inches long, exactly in the middle line and ending over the upper border of the pubes. The subcutaneous fat, often plentiful in amount, having been divided, and any vessels secured with Spencer Wells's forceps, the anterior wall of the rectus sheath is incised close to the middle line, and the fibres of one or other rectus muscle are separated from below upwards for two or three inches. The

transversalis fascia is then picked up at the lower angle of the wound and divided. The retractors now drawing the edges of the wound well apart, a layer of loose tissue and of fat, often abundant, and frequently having large veins in it, will next come into view, lying over and concealing the bladder. This must be torn through carefully and as cleanly as possible at the lower end of the incision near the pubis, a blunt dissector being used for the purpose. The fat is then drawn upwards with the finger so that the peritonæum may be displaced out of harm's way generally without being seen at all. Any veins which cross the wound (and a transverse branch lies often just opposite the site of puncture into the bladder) should be secured with forceps. If

FIG. 247.



Supra-pubic cystotomy. The rectus fibres have been separated and the sub-peritonæal fat and peritonæum displaced upwards. Tissue forceps are better than sutures for holding the bladder up against the parietes.

one is opened at this stage, the field of the operation will be obscured by most troublesome hæmorrhage.* This must be arrested by pressure-forceps, which act also as retractors, by sponge-pressure, or a very hot saline solution; prolonged manipulation in arresting hæmorrhage here may be the cause of that cellulitis later on which is so much to be deprecated. The anterior surface of the bladder will now be recognised by its pink colour, the fibres of the detrusor urinæ,

* M. Guyon in his second case met with most profuse hæmorrhage: "Nous essayâmes, mais assez vainement, à nous opposer à l'envahissement de toute la plaie par une nappe de sang sans cesse renouvelée." After repeated and fruitless attempts to arrest this hæmorrhage, the bladder was opened and the stone removed. The hæmorrhage ceased entirely on the removal of the rectal bag. The patient, aged 69, died with purulent infiltration of the sub-peritonæal connective tissue. Such severe hæmorrhage is very rare.

and by its fluctuating under the finger. Veins often are met with again here on the bladder itself, longitudinal, transverse, and occasionally plexiform. Great care must be taken not to open up the fatty connective tissue which lies between the anterior surface of the bladder and the pubes. A spot on the anterior surface of the bladder having been chosen about three-quarters of an inch* above the pubes, it is punctured (a hook or retaining sutures (vide Fig. 247) being used if thought desirable), and the left index finger at once introduced to feel for the stone. The finger at the same time keeps the bladder hooked up, and prevents it settling back into the pelvis as the bladder collapses. The stone is best removed by two fingers, or, if preferred, by forceps or scoop. The fingers, if successful, have the advantage of not risking any injury to the mucous membrane. Removal of the stone is not always easy; it falls back into the fundus, or into a retro-prostatic pouch out of reach. An assistant's two fingers passed into the rectum may be of service in pushing the stone forwards. Care must be taken not to bruise or lacerate the edges of the vesical incision or to break the stone into pieces by attempting to remove it through an aperture which is too small; it is far preferable to enlarge the latter by stretching with two fingers without delay. More room can thus be obtained without increasing the bleeding from the wall of the bladder.

Great difficulty may be met with in removing an encysted calculus, owing to the fact that the stone usually entirely fills the sac, the neck of which is frequently quite narrow. If the neck cannot be sufficiently dilated to deliver the stone, whole, through this, the plan recommended by Hurry Fenwick (*Med. Ann.*, 1901) may be made use of. It is described as follows:—"If there is a projecting nose, it is snapped off and removed—if no dumb-bells exist, then the tiny aperture must be located—slightly dilated by the point of the forefinger, and if possible the stone must be freed in its sac. A caisson or speculum should then be passed on to the aperture, a beam of light thrown along the channel to expose the white surface of the stone, a blunt graving tool or chisel being guided on to it under control of the eye. The assistant now passes his finger into the rectum, and supports the stone from behind, while the surgeon steadies the point of the chisel on the stone, and taps its head smartly with the mallet. The stone is fractured, as it is chiefly phosphatic material. With a little manipulation the stone is turned, another section is made, and so on, until the pieces can be safely pulled through the orifice of the sac into the caisson and out."

When the sac is low down or lateral, the lower margin of its neck may be safely incised, without risk of opening the peritonæum. A stone impacted at the lower end of the ureter may if necessary be released by incising the mucous membrane over it in a direction parallel with the course of the ureter.

The question now arises of closing the opening with sutures or leaving it open, in part at least.

* The spot chosen must not be too low, or infiltration may take place into the cavum Retzii behind the pubes. It is also more difficult to sew the wound if it is placed too low; if too high, drainage will be interfered with and the peritonæum endangered. A transverse incision into the bladder is a little more easy to close, but it injures the detrusor more.

The drainage of the bladder by a catheter, in the urethra, or by suction and syphonage (p. 603) is so difficult, the patient's condition so very unsatisfactory* for the first week or so, owing to the constant soakage in spite of voluminous dressings, that wherever it is possible the bladder opening should be closed by sutures. One of the first to adopt this plan successfully was Dr. L. S. Pilcher, of New York: a catheter was used till the ninth day, the patient, an adult, went out on the fourth, and on the fourteenth day was shown to the New York Medical Society, primary union having taken place throughout the whole extent of the wound, without unpleasant symptoms of any kind. Mr. R. W. Parker had an equally successful case in a child aged 3. There have been a number of others. Mr. Anderson, of Nottingham (*Lancet*, vol. i. 1890, p. 898), sutured the bladder in a boy aged 10. Acute pneumonia complicated the after-treatment, and on the night of the fourth day (the superficial sutures being removed and the wound healed) prolonged coughing tore open the wound. The case did well. Mr. Pollard described three cases in which the bladder was sutured after supra-pubic lithotomy in children. Urine leaked through in each case on the third day. All did well. In a very interesting paper by Mr. Bond, of Leicester (*Lancet*, vol. ii. 1889, p. 260), it will be seen that in three out of four cases in which the bladder had been sutured, some urine escaped once about twelve hours after the operation. This did not delay the union. A continuous Lembert suture of catgut put in efficiently will suffice (p. 353). Care must be taken not to perforate the mucosa. The first suture may be reinforced by a second one in some cases, especially if there has been any bruising of the edges. When the bladder is sutured great care must be devoted to securing and maintaining efficient drainage through the catheter, for if the bladder is allowed to get distended, pelvic extravasation is almost certain to occur. A large sized and large eyed soft catheter is inserted before the bladder is closed, and its eye should be just above the vesical orifice. It is carefully secured so that it may not slip either in or out, and the rubber tubing attached to it has its other end immersed in antiseptic lotion in a vessel attached to the side of the bed. The whole drainage apparatus must be airtight to be efficient. If the eye of the catheter gets blocked with clot, this must be displaced at once, by running some boracic lotion. Bergmann drains through a median perinæal puncture, which is made by cutting upon the points of forceps, passed from the bladder along the urethra. This method may be adopted in some cases in order to avoid supra-pubic drainage.

Sutures should not be employed (1) where there is cystitis, and the urine ammoniacal or the kidneys diseased and the renal excretion poor, (2) where the bladder is irritable, thickened, and the better for drainage, (3) where the extraction is difficult and prolonged, and the parts necessarily bruised, (4) where there is any reason to expect bleeding; in such cases the clots will cause violent tenesmus, and, probably,

* This is especially the case in elderly flabby patients with damaged kidneys, and unsatisfactory vital power and will. Such tend to become apathetic, to lie helplessly on their backs down in the bed, thus easily getting stasis in their lung bases and broncho-pneumonia, together with a low septic condition of the wound. The nursing of such cases is greatly helped by suture of the wound, and thus keeping the patients dry.

giving way of the sutures, (5) where there is any stricture or an irritable condition of the urethra sutures are inadmissible.

Where sutures are not used, in order to prevent extravasation, the cut edges of the bladder should be sutured with fine catgut to the fascial and deeper edges of the wound, two or three sutures being placed on either side, and one below at the lower end of the incision so as to shut off the tissues behind the pubes. Another way is to partly close the vesical wound with purse-string inverting sutures, until it grasps the large rubber tube inserted. A suture may be used on either side to keep the bladder in contact with the parietes.

Two or three buried catgut sutures then draw the muscle fibres and aponeurosis together above, while three or four more unite the skin, or salmon-gut suture alone may be used, some of them being passed deeply so that they approximate the muscles; buried sutures are thus avoided. Iodoform and collodion should be brushed over the united portion of the wound, and the bladder should be drained by Mr. Cathcart's method (p. 603). If this has not been provided, a large Thomson's supra-pubic tube should be inserted, and every attempt made by a regular supply of dry dressings, and, after the first twenty-four hours, turning the patient on his sides for a few hours alternately, to prevent any part becoming sore from the constant soaking. But if the bladder is not sutured, only some such method as Mr. Cathcart's will keep the parts dry and save the patients from the great risk of extravasation. Where sutures are used it will be well not to unite the linea alba and skin below. For the first few days it will be unwise to trust to the patient's voluntary power of expulsion, and if the catheter becomes plugged, or if it is not passed just when required, some urine, possibly septic, may be forced out between the sutures before the bladder wound is finally closed, a process which must take two or three days. If this extravasation take place deep down in a wound like this, where the superficial parts have been closed, there is the gravest peril of a fatal issue from septic purulent infiltration of the connective tissue of the *cavum Retzii*, pelvis, and abdominal wall.

To avoid this, the prevesical space must be drained in all cases by means of gauze or a rubber tube with a wick of gauze inside it. After 3 or 4 days the drain can be safely removed and the wound allowed to close. Belfield (*Ann. of Surg.*, January, 1907, p. 101) drains the space in front of the bladder through the perinæum. He opens the membranous urethra upon a grooved staff, and introduces a gorget. "A small trocar and cannula is passed from above along the anterior surface of the bladder and prostate into the groove of the gorget. The trocar being withdrawn, a few silkworm strands are threaded through the cannula and along the gorget out through the perinæal wound (a small perforated rubber drain may be attached and drawn through by the threads). A large soft catheter with multiple perforations having been introduced into the bladder for perinæal drainage, the supra-pubic incision, bladder and abdominal wall are closed completely, except where the threads protrude, the anterior bladder wall being anchored near the recti muscles. Urine which may leak through the bladder wound, and tissue fluids, find ready exit at the bottom of this space. In nine out of eleven cases, in which I have made this operation, the wound was entirely healed within two weeks; in the remaining two—

prostatectomies in which oozing blood was allowed to block the perineal drain—the wound was reopened for the insertion of a larger drain.” Although this method is worth trying I do not anticipate that it will prove to have any real advantage over the method described above, and it has the disadvantage of adding a perineal fistula.

A few words may be said here about *the peritonæum*. With such distension of the bladder as has been advised, with an incision not begun too high up and carried well down over the pubes, with a moderate incision into the bladder, it is most unlikely that anything will be seen of the peritonæum. It may be very indistinctly felt at the upper part of the wound, but this is, usually, all.

If, after careful distension of the bladder the peritonæum still seems to encroach too far upon the anterior surface of the bladder, it may be pressed upwards and held out of the way by one or two fingers of an assistant, or, if needful, gently peeled upwards off the bladder with a steel director.* In elderly people with lax tissues and large stones requiring free incisions, the peritonæum covered with its fatty tissue is more likely to be seen rising and falling in the upper angle of the wound. There is more danger of opening the peritonæum when the bladder is contracted, and especially when either supra-pubic puncture or cystotomy has been previously performed and has disturbed the normal relations of the parts.

If, what is most unlikely with the recent improvements in the operation, the peritonæum should be punctured before the bladder is opened, the puncture should be picked up and tied around with chromic gut. If the opening is more than a puncture the cut edges of the peritonæum should be sutured carefully with catgut, and the operation continued.

If the opening is made after the bladder is opened, the surgeon must decide, according to the amount and character of the urine which has escaped, between suturing the opening and enlarging it upwards, so as to thoroughly sponge out or cleanse by irrigation with a 2 per cent. solution of boracic acid, the peritonæal cavity. But these accidents are most unlikely nowadays.

One of us operated by this method fourteen times some years ago, the patients ranging from 3 to 62 years. Four only of the stones were large. Two were just over 2 oz., a third was 5 oz.; in the fourth, a young woman, the stone, formed round a hairpin, weighed 6 oz. In five they were multiple. In seven the urine was alkaline and foul. Four cases were fatal—the sixth, a lad of 19, an orphan, in wretched condition of body, and in much misery from pain. Perhaps it would have been wiser to have waited longer, in order to feed him up before operating. His pain, however, was so severe that the operation was

* In only three of my 14 cases did I have any trouble with the peritonæum. To give one instance, in an elderly patient of Dr. Bell's, of Blackheath, with two lithic acid calculi each weighing 1 oz., the peritonæum almost reached the level of the symphysis. It was, however, easily detached from the bladder and held up with a retractor. I closed the upper part of the wound carefully over it, and sutured the edges of the bladder to the deep part of the wound. A good recovery followed in this and the other two cases, which were similar. At the Congress of German Surgeons in 1886, Gussenbauer, Sonnenberg, and Kramer mentioned cases in which the peritonæum was found adherent to the symphysis. In one case it was opened with fatal results; in another, the opening was sewn up and the peritonæum safely separated from the pubes.

performed a week after his admission into the hospital. He did excellently for forty-eight hours, then symptoms of pelvic cellulitis set in, proving fatal on the fourth day. The other case was one of multiple stones in a man of 58, much run down in strength. Eight calculi were removed, composed chiefly of urates. The patient sank shortly after. His kidneys proved to be in an advanced stage of granular degeneration. Two other patients, elderly men, died of kidney failure, one on the fourth day, the other twenty-two days after the operation.

Southam (*Brit. Med. Journ.*, 1904, p. 1190) records a death rate of nearly 24 per cent. for 46 supra-pubic lithotomies. This mortality seems to be unusually high; "it must be remembered, however, that the cases so treated were all unsuited for lithotripsy, the latter operation being contra-indicated in each instance—with one exception—on account of the large size of the stone, associated either with enlargement of the prostate, and an unhealthy state of the bladder and urine, or with a feeble condition of the patient, in consequence of which the shock of a prolonged crushing operation would not have been well borne. The fatal result in these cases was due in several instances, when the patients were advanced in years, to sudden heart failure, coming on at some interval after the operation, when all was apparently progressing favourably; in others, as proved by necropsy, it was the result of pre-existing secondary renal disease, death being preceded by suppression of urine and other evidences of uræmia."

"Barling collected 72 cases of supra-pubic cystotomy performed in London and provincial hospitals between 1888 and 1892, the patients all being under 20 years of age, and in 15 instances there was a fatal result, giving a mortality of 20 per cent."

While on some points connected with the operation my mind remains open, I am strongly of opinion that, with carefulness, it is a safer operation than the lateral method for those who only perform lithotomy occasionally, and for large stones—*e.g.*, over 1 oz. I am certain that no benefit is to be gained by substituting it for the lateral in the case of children.

MEDIAN LITHOTOMY.

Disadvantages.

1. It gives very little room, and is unsuited to any save the smallest stones. 2. The wound being small, the surgeon cannot bury his knuckles in it, or reach the bladder as easily as in the case of the larger lateral wound (Cadge). 3. The rectum on the one hand, and the bulb on the other, are in greater danger than by the lateral method (Cadge). 4. Troublesome bleeding is more frequent (Cadge).

Mr. Cadge, having operated on 50 or 60 cases by the median method, has given it up for the above reasons, and also because his mortality has been rather higher.

Advantages.—Recovery is often extremely rapid; the urine quickly resumes its natural route; and the wound, instead of gaping and healing slowly as the lateral wound does, heals almost by first intention.*

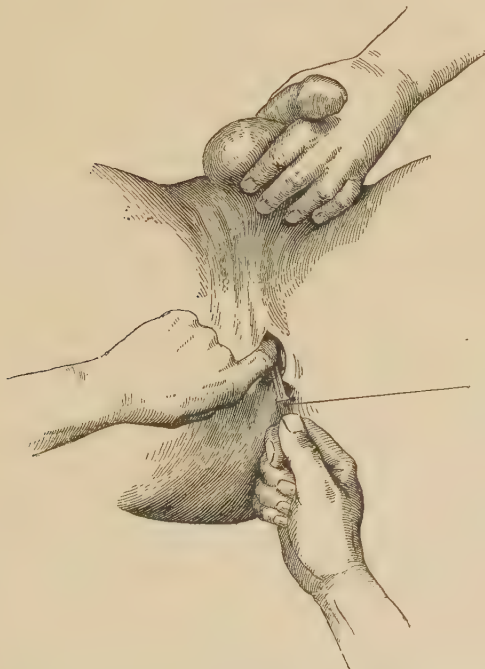
* Dr. W. T. Briggs, of Nashville (*Trans. Amer. Surg. Assoc.*, vol. v. p. 127), thus sums up the advantages of median lithotomy: (1) It opens up the shortest and most direct route to the bladder. (2) It divides parts of the least importance. (3) It is an almost

It inflicts a minimum of damage; for these reasons Mr. Jacobson considers the operation to be the most suitable for elderly men with comparatively small stones.

The above do not, however, compensate, in Mr. Cadge's opinion, for the disadvantages. He would avoid it, especially in children, in whom it is by some preferred, as in them a free incision is necessary to facilitate the passing of the finger into the bladder, while here the limit of space for the knife is very small indeed.

The operation is suited for prostatic calculi, but, if these are associated with any larger one in the bladder, the surgeon must either

FIG. 248.



Median lithotomy. The left fore-finger being introduced along the director, which was passed into the bladder before the withdrawal of the staff. (After Heath.)

crush this before he can extract it through his small incision, or perform a supra-pubic operation.

bloodless operation. (4) It affords a passage for any calculus which can be safely extracted through the perinæum. (5) It affords the best passage for the fragmentation of unusually large calculi. (6) It reduces the death-rate to a minimum. In answer to the objection to the median operation that it is unfitted for the extraction of large stones, Dr. Briggs states that by making it a medio-bilateral operation (*vide infra*), as large stones can be removed by it as can be extracted by the lateral method. Since adopting the above modification, Dr. Briggs has had the following excellent results: Of the first 74, none died. Then two died, but one of these had a pelvic abscess before the operation, and the other died at the end of three months with phthisis, and the wound unhealed. Since then Dr. Briggs has had 46 cases with one death,

Operation.—If a curved* staff be used, one with a wide groove is chosen, and passed and held with its handle inclined towards the umbilicus (p. 616), the patient being in lithotomy position. The surgeon passes his left forefinger into the rectum so as to steady with its tip the staff in the membranous urethra and also to guard the rectum from puncture, while at the same time note is taken of the depth of tissues between the knife and the finger. A straight and very sharp bistoury is then pushed, with its back downwards, through the skin, half an inch above the anus, straight on into the groove in the staff, which is now held well hooked up against the pubes. The knife, having distinctly exposed the groove, is pushed a little onwards so as to nick the apex of the prostate, and next, as it is withdrawn, it is carried upwards in the raphé so as to divide the soft parts for one inch or more, according to the size of the stone. The finger would now be passed into the bladder, and the staff withdrawn. As, however, the staff occupies too much room in the limited wound to allow of this, a director (Fig. 248) is passed in along the groove, the staff withdrawn, and then the finger introduced along the director through the neck of the bladder. This is dilated sufficiently and the scoop or forceps introduced. If the finger cannot be introduced along the director, forceps of different sizes may be passed and used to dilate the passage sufficiently.

Some surgeons prefer to make the incision from above downwards, but cutting from below upwards would seem better to protect the bowel.

If a straight staff be used, the surgeon introducing his knife as above, and having cut upon the staff distinctly both to himself and the assistant who is holding it, takes it into his left hand, and, having brought it down into an oblique position, runs his bistoury along the groove so as to nick the prostate; the enlargement of the wound and the rest of the operation are conducted as above.

Where the stone is too large to be extracted by the ordinary median operation, the **medio-bilateral modification** introduced by Gouley, 1828, and used so successfully in America by Dr. Briggs, should be employed. It consists in making, after a longitudinal incision in the raphé, a slight bilateral cut in the elastic ring at the neck of the bladder and the prostate.

Complications and Causes of Death after Lithotomy.—1. Shock.—This is rarely severe, save in patients much pulled down, and after prolonged operations. Children, as a rule, however reduced,† rally well after the operation (Sir J. Paget, *Clin. Essays*, p. 404). 2. Hæmorrhage.—If milder methods fail this is best met by plugging the wound with the umbrella-plug, or by leaving *in situ* a pair of Spencer Wells's forceps, which will also aid the drainage. 3. Pelvic cellulitis.—This, the most frequent cause of death, is due either to extravasation of urine,

* Mr. Erichsen recommends a rectangular staff, the angle of which rests against the apex of the prostate, and is thus much easier to find in the perinæum. The special staff is, however, often difficult to introduce, and a curved one, held so as to project its curve in the perinæum, will be easily found.

† Occasionally, however, even nowadays, where the history is of long standing and the kidneys much impaired, they are too far gone for operation. See a case by Mr. Hutchinson (*Clin. Surg.*, pl. lxxvi. vol. ii, p. 126).

probably septic, or to laceration of the deep parts, or both. It usually comes on within forty-eight hours. 4. Peritonitis.—Usually combined with the above. 5. Septic complications.—Septicæmia may occur early with pelvic cellulitis. Pyæmia, on the other hand, may come on later. 6. Surgical kidney. 7. Retention of urine.—Common enough a few days after, from swelling of the parts. Rarely more serious. 8. Suppression of urine. 9. A sloughy, phosphatic state of the wound. 10. Sloughing of the rectum (p. 620). 11. Cystitis.—Rare. 12. Epididymitis. 13. Later complications rare, but troublesome. 14. Fistula. 15. Incontinence. 16. Sterility.

**LITHOTRITY—OPERATION WITH SEVERAL SITTINGS—
RAPID OPERATION WITH ONE SITTING AND EVACU-
ATION—LITHOLAPAXY—PERINÆAL LITHOTRITY.**

Choice of Operation—Lithotritry or Lithotomy.—It is hoped that the following points, while they do not in the least exhaust the subject, will be found of practical assistance:

1. Amount of experience of the surgeon.—Every attempt should be made to become familiar with the use of the instruments, both outside the body and also by passing a lithotrite for examination of a calculus whenever one is felt on sounding. No surgeon who has not had abundant opportunities of practising the needful manipulations will do wisely in attempting to crush a hard stone which weighs an ounce.

2. Size, kind, and number of stones.—As to size, up to 1 oz. or $1\frac{1}{2}$ oz., it is probable that, with the majority of stones, in fairly practised hands, lithotritry is immensely superior to lithotomy as far as immediate mortality is concerned. I use the term “immediate” advisedly, because of the more frequent recurrence, with its results, after lithotritry, and would refer my readers to the remarks on this point at p. 636. Much larger stones may be successfully crushed by an experienced operator with the specially strong instruments now made. Freyer (*Lancet*, Dec. 12, 1896) gives a list containing 31 cases in which the stone averaged 2oz. 5drs. in weight, all of which were successfully crushed. The largest stone which Freyer has crushed weighed $6\frac{1}{8}$ oz., the operation lasting two hours. The same author, moreover, considers that in all cases trial should be made of litholapaxy before a cutting operation is performed.

Mr. H. Milton (“Lithotritry, Simple and Complicated,” *Lancet*, April and May, 1896) records an epoch-marking case in which he crushed a stone (urates and phosphates) weighing over 12 oz. The operation lasted two hours, and an especial lithotrite with a gape of five inches was used. Such an operation is, of course, only possible for an expert with especial experience, such as Mr. Milton’s in Egypt. This surgeon had before (*St. Thos. Hosp. Reports*, 1891) referred to the extraordinary tolerance which Orientals show to all operations connected with the genito-urinary apparatus.

The difficulty of a decision sometimes met with here is well expressed by the words of Sir W. Fergusson, that the greater is the experience of the surgeon the greater will sometimes be his doubt.

To anyone with very limited experience rashly contemplating an

attack upon a hard stone I would recall Mr. Milton's words (*loc. infra cit.*): "During the first twenty minutes of a long crushing most men can maintain the necessary delicacy of manipulation, combined with the exercise of considerable force; but when it comes to working at the same strain for a second, third or fourth, or even fifth, sixth or seventh period condition begins to tell . . . this force has to be exerted with the greatest discrimination and the greatest patience." In addition to the above must be remembered the frequent introduction and withdrawal of instruments, lithotrite and evacuators, and the result upon the neck of the bladder and the deep urethra.

More important than the size of the stone is its composition. There is, of course, no comparison between a pure lithic acid or oxalate of lime stone on the one hand and an alternating stone with a good deal of phosphate or urates in its composition, as a test of skill and endurance both on the part of the surgeon and his instruments. Dr. Hingston, of Montreal (*Intern. Encycl. of Surg.*, vol. vi. p. 311), in his article on Lithotrity, points out that sometimes the apparent softness of a stone is most misleading.

Having found an enormous stone in a patient, he employed lithotrity, as the stone seemed soft. After getting away a large quantity of phosphatic matter, he was driven to perform lithotomy, and removed, by the lateral method, a calculus weighing over 5 oz. consisting mainly of oxalate of lime and uric acid.

There are several other *fallacies in gauging the size and number of calculi*. Thus the lithotrite may again and again seize a stone which only weighs $\frac{1}{2}$ oz. in its long diameter, if flattened, of two inches. Testing by passing a staff around or rubbing it over a calculus is often most fallacious, and examining per rectum may, if the bladder be thickened, give evidence of a stone apparently much larger than it really is. Mr. Cadge (*loc. supra cit.*) points out a fallacy with regard to multiple stones. "When more than one stone is present, it is customary to seize one, fix it in the instrument, and proceed to sound afresh; this, however, may mislead, for a stone, having been grasped by the tips of the blades and moved about in the bladder, will sometimes rotate a little in the blades of the lithotrite and communicate a grating feel to the hand which is very like touching a second stone."

3. Condition of the urethra.—Two points have to be considered here—(a) how far will the urethra *admit* instruments—*i.e.*, how far is its canal normal or diminished by stricture; (b) how far, even if normal in calibre, will the urethra *tolerate* instruments. With regard to the first, a stricture, if admitting of dilatation, is not an obstacle to lithotrity; on the other hand, an old stricture with surrounding induration and fistulæ, or a less severe form which produces rigors and fever at each attempt of dilatation, are best submitted to lithotomy, which gives the best chance for the stone, and at the same time offers the much-needed relief of rest to the stricture. Mr. Cadge gives the following practical hint in these cases of stone combined with stricture: "Sometimes a stone is detected in the urethra behind the stricture, as well as one or more in the bladder, or it may be partly in the bladder and partly in the urethra, and in these cases median lithotomy will not only remove the stone, but may go far to remedy the stricture by external division."

With regard to an irritable urethra—*i.e.*, one without a stricture and only admitting instruments with the aid of anæsthetics—the chief points to consider are the size of the stone and the ability of the surgeon to deal with it by litholapaxy. If the calculus cannot be evacuated at once, or requires more than one sitting, lithotomy should be preferred, owing to the results of the passage of instruments and prolonged voiding of fragments.

4. Condition of the prostate.—An enlarged prostate is of great importance, not only from its power of obstructing the operation, but from the changes which it brings about in the bladder. Thus, it interferes with the efficient use of instruments, the picking up of a stone even with the blades reversed, and the finding of the last fragment. Again, the use of the lithotrite and the passage of evacuating tubes readily lead to hæmorrhage, and this again by clots prevents the free and easy use of the evacuator. Later on, phosphatic deposit, imperfect evacuation, residual urine, and recurrence of stone symptoms are all frequent accompaniments of enlarged prostate.

5. Condition of the bladder.—Formerly it was held needful to operate with several ounces of fluid in the bladder, and some suggested to draw off the urine and inject 8 or 10 oz. of fluid. This amount has now been reduced to something more like 4 or 6 oz. As, if the urine is healthy, no fluid is more suited to the bladder, the surgeon should content himself with following Sir H. Thompson, and “ask the patient to retain his urine for a little less than his accustomed period before the sitting; that is, if he is naturally able to retain his urine for about an hour, he is requested to pass it forty minutes before the time of the visit.”

Some other changes* in the bladder require mention. (a) Sacculation pouches or sacs, whether mere hollows behind or at the sides of an enlarged prostate, or hernial protrusion of the mucous membrane between the muscular fibres, may be the starting-point of calculus by entangling *débris* or tiny fragments. In Mr. Cadge's words: “The imprisoned fragment first fills up the cyst, then, by continual accretion of phosphates, it grows up into the bladder like a mushroom, and is probably again and again nibbled off by the lithotrite, each time with temporary benefit, until the patient dies, worn out with chronic cystitis and pyelitis.” Mr. Cadge goes on to say: “By turning the aperture of the evacuating catheter towards these pouches, and by the free use of the aspirator in all directions, the fragments may be washed out of them and all removed, but it cannot be denied that it is always a serious matter to shatter a stone into innumerable fragments in a bladder of this description.” (b) Atony, whether with or without an enlarged prostate. The importance of this is obvious, as tending to recurrence of stone by some small fragments not being expelled in spite of the vigorous use of the aspirator, and also to cystitis from imperfect emptying of the bladder.

* Several allied conditions exist in which the position of the stone is complicated with difficulties—*e.g.*, (1) where the stone has been partly in the bladder and partly in the urethra. (2) The stone has been lodged entirely or partly in a diverticulum of the bladder. (3) The stone has been lodged in a deep pouch behind the prostate. For helpful information on these and many other points I would advise my readers to consult Mr. H. Milton's paper on “Lithotritry in Cases of Stone, Simple and Complicated,” *Lancet*, April and May, 1896.

6. Condition of the kidneys.—Here I may again quote a veteran's opinion, that of Mr. Cadge: "What is to be said of stone complicated with kidney disease, such as albuminuria and chronic pyelitis and atrophy? In these cases all operations are fraught with danger, but it is probable that the least danger will be met with from a carefully conducted one-sitting lithotripsy. So, too, in those cases of constitutional disease combined with stone, such as diabetes, tabes, and other spine disease, it will be well to avoid the shock and hæmorrhage of lithotomy, and proceed, if any surgical proceeding is allowable, by lithotripsy." The surgeon, in considering an operation in any of the above diseases, will weigh well the size of the stone, his ability to cope with it at one sitting, and the amount of suffering which it causes the patient.

7. Age.—Here, especially, age is not to be reckoned by years alone.

Recurrence.—As no one, to my knowledge, has spoken out on this subject with such helpful candour as Mr. Cadge, with his experience of 300 cases of stone, I make no apology for quoting once more from his writings (*Brit. Med. Journ.*, July 3, 1886): "Although the immediate and direct mortality of lithotripsy is small, the recurrence of stone is lamentably frequent. In my own list of 133 cases, there were eighteen in which recurrence, one or more times, took place, being about one in seven. Sir H. Thompson, with a much larger number of cases, gives about the same proportion. I am disposed to infer, however, that recurrence is more frequent even than this, because it is not likely that all who get relapse apply to the same surgeon again. Living, as I do, in a local centre, and drawing cases chiefly from a limited area, I am probably more able to trace, and more called on to treat those who suffer a second and third time, than he who lives in the metropolis and draws his cases from great distances. Patients may, and frequently do, apply to the same operator once or twice; but, after a time, they either apply to their own surgeon, or they decline further treatment, and too often their subsequent history is one of painful endurance of chronic bladder disease and gradual exhaustion. If, moreover, there be added to the list those numerous cases of phosphatic deposit or concretions so frequently noticed after lithotripsy, the relapses would, I believe, reach to nearly 20 per cent. This seems a heavy indictment to bring against lithotripsy, but I am afraid there is no gainsaying it; and, if so, it would be wrong to pass it over or make light of it. Many of these relapses might be prevented if the patients would observe directions and persevere with treatment. It certainly is so with the unenlightened and uncomplaining hospital patient. Feeling himself well, or what he considers well, he goes to his work, and neglects the use of the catheter and fistula means; and, instead of returning in a month or so to have his cure completed, or a minute remaining fragment removed, he toils away as he best can, and returns, perhaps in a year or two, with a fresh uric-acid stone, or with chronic cystitis and a phosphatic one. The educated, sensitive private patient, on the other hand, will watch his symptoms narrowly, and return if the slightest indication of the old mischief should reappear. . . . This frequent recurrence must be due either (1) to the descent of a fresh stone from the kidneys, or (2) to a fragment of stone having been left at the first operation. As to the descent of a fresh stone: there can, of course, be no doubt as to

the occasional occurrence of this cause, just as we see it occur after lithotomy. The bladder being entirely cleared of stone, there will be the same liability to the descent of a fresh renal calculus after one operation as after the other. What then, let me ask, is the fact as to lithotomy? I have already shown that there were only 21 cases out of more than 1000 of lithotomy at the Norwich Hospital in which recurrence was clearly traced to perfectly fresh formations, coming, like the first, from the kidney, or about one in fifty; whereas, in Sir H. Thompson's list of about 600 persons treated by lithotrity, he mentions 61 cases in which he operated twice; nine, three times; three, four times, and two, five times—seventy-five in all, or about one in eight. The inference from these data seems to me to be inevitable, that relapse of stone after lithotrity is chiefly due to other causes than the descent of a fresh stone. To my thinking the majority of recurrences is caused by the great difficulty in ensuring the complete removal of all the *débris*; I have already referred to this in old persons with enlarged prostates and feeble atonic bladders, and it is this class of patients who are especially liable to relapse." Mr. Cadge goes on to show that the tendency to phosphatic deposit after lithotrity is not due to vesical incompetence and residual urine alone without some overlooked fragment, and that the improved method with repeated washings will still fail to discover a last fragment in some bladders. At the present time the cystoscope and the evacuating lithotrite should do much to prevent fragments from being overlooked and left in the bladder.

More recently Mr. Reginald Harrison has given (*Lancet*, Nov. 12, 1899) an analysis of 110 operations for stone, 101 of which were litholapaxies. Recurrence, necessitating further operation, took place twenty-three times, *i.e.*, in nearly 23 per cent., a considerably greater proportion than Mr. Cadge gives. In all but one case the recurrence was associated with enlarged prostate. Mr. Harrison considers that this is accounted for in several ways, partly by the fact that *débris* may be left behind in sacs and pouches at the time of operation, and partly owing to the inability to completely empty the bladder later, so that fresh stones descending from the kidneys are retained while other foreign bodies, such as shreds and sloughs from an inflamed bladder, may form nuclei for the formation of fresh stones. With a view to preventing recurrence in these cases, the author lays great stress on the importance of thorough washing out at the time of operation, also once a week for three or four months after the operation, and also of the adoption of measures aiming at the reduction of the size of the prostate. At the present day it is best to enucleate the prostate (unless there is some grave contra-indication) and thus remove the cause of the stone-formation and recurrence.

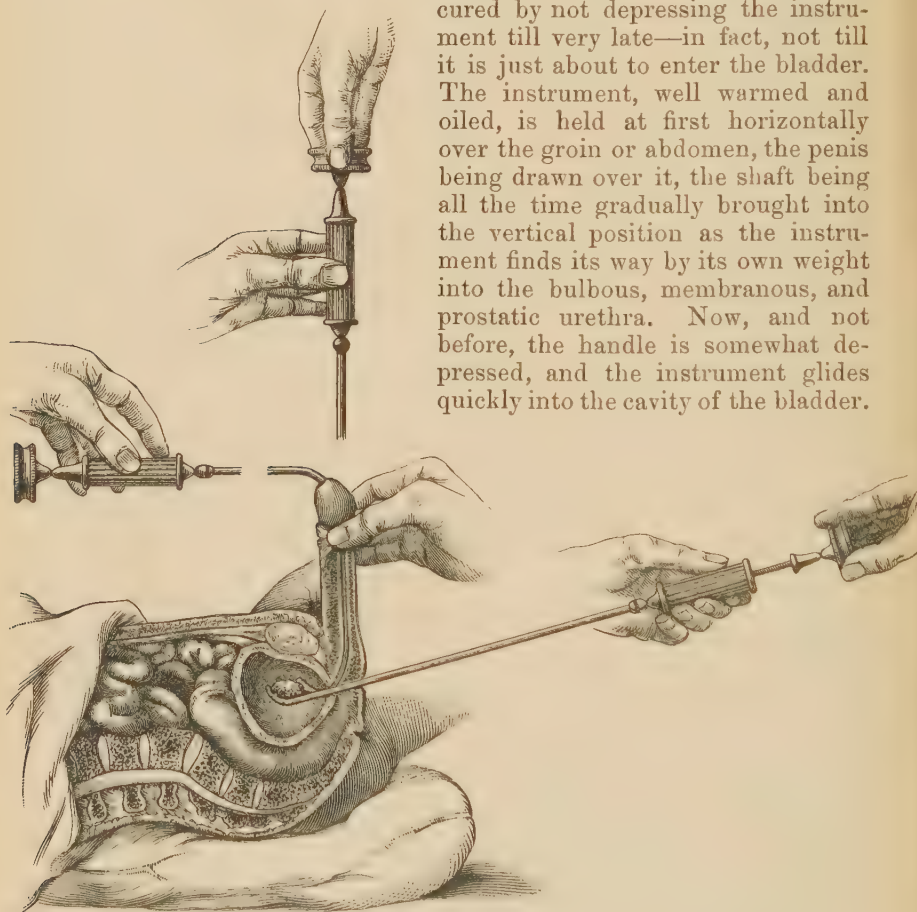
Operation (Figs. 249—251).—The preparatory treatment has been much simplified. It is now recognised that the best course is to remove the stone at once: previous passage of sounds, and injections of the bladder,* are now but little used. A few days' rest, bland, unirritating liquid diet, urotropine if there is cystitis, mild aperients, and securing sleep are the chief indications.

The instruments required will be gathered from the following

* The amount of urine to be held, in most cases, has already been mentioned (p. 635).

account: The patient having been anæsthetised and lying on a firm couch or mattress close to the right side of the bed or table, with his pelvis raised, and the body and limbs well protected from chill, the surgeon, standing on the right side with his instruments close to him, introduces his sterilised lithotrite. In doing this care must be taken not to get the blades hitched either just in front of the triangular

FIG. 249.



Lithotrity, showing the position of the lithotrite, during introduction, grasping the stone and crushing. (Heath.)

If the prostatic urethra is enlarged and lengthened, the surgeon may think that he has reached the bladder, but the fact that the gentlest lateral movement of the lithotrite is interfered with will show him his mistake. Pressure with the instrument is alone allowable at the meatus; some rotation may be called for in guiding the instrument through the triangular ligament or past an enlarged prostate. In this latter case also the handles must be further depressed, and a finger in the rectum may give help.

When the lithotrite has entered the bladder it should be allowed to slide, very gently, down the trigone, being now held very lightly so as at once to detect the site of the stone, which it now often touches, but must not displace.

If the stone is felt on one side, the instrument is gently turned to the opposite one, opened, and then turned towards the stone. If it be not felt, the handle of the instrument being slightly raised, and the blades very gently depressed and then opened, the stone will often drop into them.

If this fail, the instrument is turned, open, first obliquely, then more horizontally, first to the one side, then to the other. In the event of the stone still eluding the lithotrite, which is most unlikely, it should be sought for with blades depressed. To effect this, the blades, closed, are raised off the bladder floor by depression of the handle, carefully reversed, and then depressed again so as to sweep lightly over the floor. They are then gently opened and closed, vertically first and then obliquely, so as to complete the examination.

During the above, the following points must ever be borne in mind :

(a) The handle and shaft of the lithotrite are to be kept as steady as possible, so as not to jar the sensitive neck of the bladder needlessly. (b) All movements are to be executed at or beyond the centre of the vesical cavity, the proper area of operating, without hurry, rapid movement* or any other which partakes of the nature of a jerk or concussion (Sir H. Thompson, *loc. supra cit.*, p. 296). (c) The male blade is never to be brought into contact with the neck of the bladder, unless this is rendered necessary by the position of the stone.

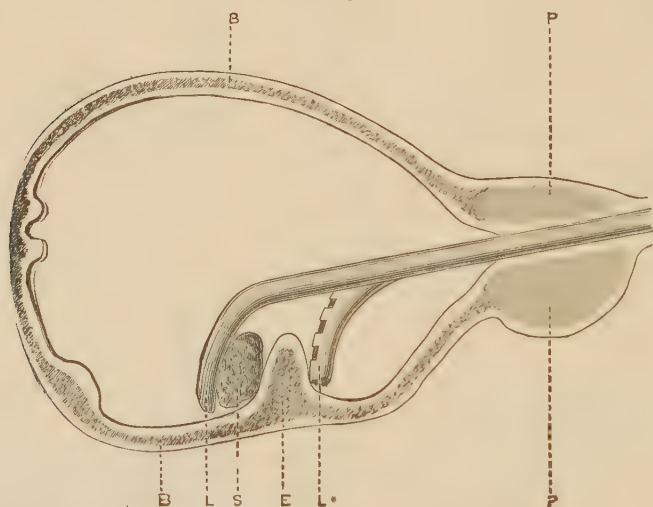
The stone being seized by one of the above manœuvres, the button† moved, and the screw connected—the screw is gradually turned at first to make the jaws bite, since a sharp turn at this time may drive the stone out either to right or left—the calculus is then carried to the centre of the cavity, which will show whether a fold of mucous membrane has been seized (Fig. 250). As the screw is applied more and more forcibly, one or other of the following will be noticed. If not well caught, and if hard, the stone will be pushed out of the jaws ; if hard and well gripped, it is felt to split into fragments ; if soft, and held, it crumbles down. If extremely hard, as a pure lithic acid or oxalate, any attempt at advancing the screw is met by this distinctly recoiling instead of advancing. Each surgeon must now decide for himself, according to his knowledge of his instruments and reliance on his power to deal with large, hard fragments, whether to continue or at once to perform lithotomy. If he continue, the resistance will be felt to give way, in the case of a very hard stone, by a sudden sharp crack ; in one less hard, more gradually. If the stone does not crack, Freyer (*loc. supra cit.*) advises that the lithotrite be unscrewed, the stone caught in another axis, and the lithotrite again screwed home. By repeating this, if necessary, the stone will usually at last give way. The same

* "Rapid movements produce currents which keep the stone more or less in motion, so that it is less easily seized than when the surrounding fluid is in a state of rest" (Thompson).

† In this respect Prof. Bigelow's lithotrite seems inferior to Sir H. Thompson's, the working of the button in the latter being smoother and less vibrating.

surgeon also recommends that in dealing with stones which are more or less round and so large that the lithotrite will not lock in any direction, the jaws of the instrument should be dug into one side of the stone and screwed up, a portion of the crust being thus broken off. By repeating this a number of times, sufficient reduction in size will take place to allow of the lithotrite being locked on the stone. In overcoming much resistance the surgeon either screws up the male blade as hard as he can and keeps it so, or, having gently unscrewed it a little, screws it up again with a series of light jerks so as to communicate blows to the stone. Cracking of the stone having taken place, the fragments will usually fall close to the original site. Thus the lithotrite has only to be kept as immovable as possible to ensure, on

FIG. 250.



This shows a risk present in operating in trabeculated bladders. While the female blade (L) is in direct contact with the stone (S), the male (L*) is in contact with a ridge of the mucous membrane (E). B, Bladder. P, Prostate. (R. Harrison.)

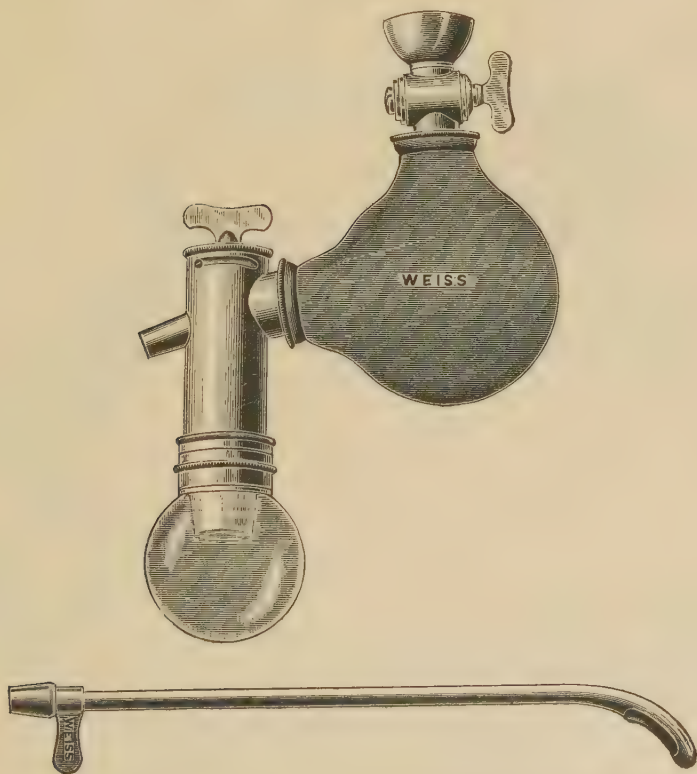
drawing out and again closing the male blade, the seizure of a fragment.* This is crushed, and the process repeated again and again till sufficient *débris* is formed. The lithotrite is then withdrawn firmly screwed up.

A straight or curved evacuating tube, No. 16 for a stone of moderate size, and 18 for a large one, is then introduced, the evacuator, filled with a warm solution of boracic acid or dilute Thompson's fluid (p. 623), is connected, the meatus being first incised with a narrow probe-pointed bistoury downwards by the side of the frænum, if needful. The tube, if curved, should be held downwards at first, but not quite on the bladder floor; then to one side or the other; then upwards, washings being carried on at the time that these movements are made. A straight

* It is not always easy to distinguish between a piece of soft stone enveloped in inspissated mucus and the lining membrane of the bladder.

tube should lie with its orifice just within the neck of the bladder. Dr. Keyes (*Intern. Encycl. of Surg.*, vol. vi. p. 244) gives this precaution as to getting rid of air entirely: "The urine, having trickled away through the tube, leaves the latter full of air, an element fatal to nicety of washing. This air may be disposed of most simply. The tube is withdrawn until its eye is in the prostatic sinus, the washing-bottle is attached, and the stop-cock turned, but no further suction made. In an instant, the air contained in the tube is heard ascending through the stop-cock and mounting into the top of the evacuator, where it does no

FIG. 251.



Sir H. Thompson's aspirator, last pattern but one. (Freyer.)*

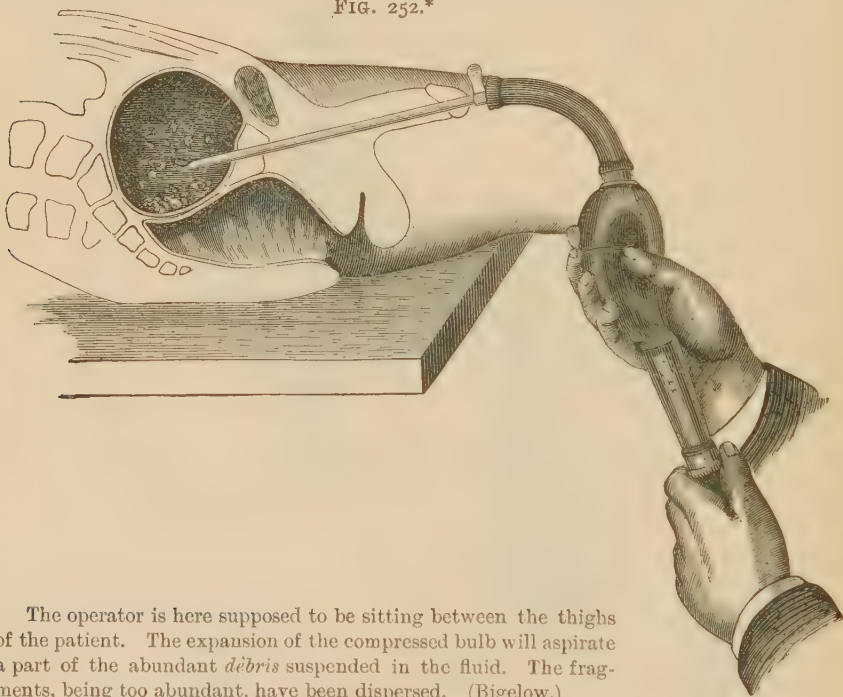
harm, and whence it cannot possibly return into the bladder." While his left hand supports the evacuator, with his right the surgeon gently but quickly squeezes the bag with sufficient force to send in about two ounces of fluid. On relaxing the pressure an outward current takes

* Of this instrument Dr. Freyer writes (*Litholapaxy*, p. 25): "I must confess a great liking for Thompson's instrument. One of this variety made for me by Messrs. Weiss I have worked with for four years, and though it has assisted at 130 operations, and been through three hot weathers in the plains of India, it is still as efficient as much newer instruments I possess, a fact which speaks well for the india-rubber employed in its construction."

place, bringing with it crushed fragments. Sir H. Thompson recommends that, after the bag has expanded and the current apparently ceased, the surgeon should wait a few seconds, "as at that precise time it is quite common for one or two of the larger fragments to drop into the receiver which would have been driven back, perhaps, by too rapidly resuming the pressure."

If, after several washings, the outflow stops, and the bag no longer expands, the end of the evacuator is blocked either by a fragment of stone, or a small calculus, a clot of blood, or the mucous membrane of the bladder. If it be a fragment, as is usually the case, or a clot,

FIG. 252.*



The operator is here supposed to be sitting between the thighs of the patient. The expansion of the compressed bulb will aspirate a part of the abundant *débris* suspended in the fluid. The fragments, being too abundant, have been dispersed. (Bigelow.)

dislodgment may be effected by sending in quickly a gush of fluid, or by the use of a gun-elastic stylet, after unscrewing the tube. Impact of the bladder generally takes place when a curved evacuator is turned upwards, and when the bladder is empty. The sensation given may be a kind of flap, simulating the click of a fragment; more often it is a dull, vibrating thud, easily recognised. More fluid must be at once injected.

If a large fragment is felt striking against the tube, or if the surgeon is certain that several good-sized fragments remain, he removes the tube and evacuator, and, while an assistant withdraws the blood-stained fluid and fragments, and recharges the evacuator, he introduces a small

* The above evacuator is now old-fashioned. Mr. Golding Bird's pattern, or the one figured at p. 641, will be found the most handy.

lithotrite and crushes up sufficient *débris* to go on again with the washings.

All the time the surgeon must keep before his eyes a mental picture of the interior of the bladder, perhaps diseased, the ureters, perhaps dilated, leading up to kidney pelves enlarged, and remember that the effects of any squeeze of his hands are felt, not only all over the bladder, but perhaps in the ureters and kidneys as well.

Detection and Seizure of the Last Fragment.—This is, as is well known, a matter of much difficulty, owing to the facility with which small fragments get hidden in some folds of mucous membrane or enveloped in blood-clot. As long as there is any “clicking” against the tube, the surgeon must persevere in his attempts at complete removal. If, after several washings, nothing comes out into the receiver, the surgeon should listen carefully over the bladder, as thus advised by Dr. Keyes :* “The tube is turned in various positions, and the operator listens. The swish of the water as it rushes in and out is heard with startling distinctness, and, if the management of the tube is skilful, any fragment of stone lying loose in the bladder is sure in a short time to be driven against the metallic tube so as to announce its presence by a characteristic click, quite distinct from that emitted by the flapping of the bladder wall against the eye of the instrument. Fine sand and thin scales of stone make no sharp click, and all such may be left to pass by Nature’s efforts, but any piece large enough to require the lithotrite can hardly escape detection by the educated ear.”

Time occupied in Litholapaxy.—This may be, on an average, from half an hour to an hour and a half. Prof. Bigelow (*Amer. Journ. Med. Sci.*, January, 1878) operated continuously for upwards of three hours, removing 744 grains, the patient making a good recovery. Mr. R. Harrison (*Brit. Med. Journ.*, Aug. 10, 1882) removed a two and a half ounce stone in two hours and ten minutes (*vide* also p. 633).

The Old and the New Operation of Lithotritry briefly contrasted.—Old lithotritry advocated short sittings, and brief use of instruments, and left the expulsion of fragments, &c., as much as possible to Nature. It probably requires less skill, and, in Mr. Cadge’s words, “is gentler, milder, less formidable altogether; no anæsthetic is probably required; no extra assistance. . . . A nervous, timid patient may prefer this to the more heroic and rougher, if more expeditious, method.” It might be added that it is less tiring to the surgeon. But these advantages are trifling as compared with its disadvantages, which are done away with by the new operation, of which the chief are the prolonged passage of fragments, often rough and angular, along a bruised urethra. Mr. Milton (*loc. supra cit.*) has invented an evacuating lithotrite—a combination of the usual crushing and evacuating instruments, which will be useful in the aged, with a moderate sized and soft stone and enlarged prostate, from the single introduction required. Moreover, the last fragments are sucked towards the jaws of the lithotrite and are therefore far more easily seized and crushed if they are too large to enter the evacuating tube.

The new method of litholapaxy, introduced by Prof. Bigelow, resulted

* *Loc. supra cit.*, p. 246. The whole of this account, with its vigorous life-like language, will well repay perusal.

from, and was led up to by, several achievements of modern surgery. Without anæsthetics, without the knowledge of the large instruments admitted by the urethra, without the pitch of perfection and power to which modern instruments have been brought, litholapaxy would still be an impossibility. Owing to its brilliant success, and the rapidity with which it relieves the patient, the single-sitting method has practically rendered the other obsolete.

After-treatment.—The chief points here are : rest in bed, the patient turning on his side to pass water, for the first few days ; hot fomentations to the abdomen, and hot bottles at first ; morphia subcutaneously, if indicated ; warm milk, barley-water, mineral waters or lemonade, a little whisky or brandy being given, if needful ; all chills should be carefully avoided. Mr. Milton (*loc. supra cit.*) recommends salicylate of soda at first every two and then every four hours if there is fever, and diuretin if there is diminution of urine. In each case the amount given is one gramme. If cystitis is present, urotropine in doses of 5 to 10 grs. thrice daily should be given.

In addition to the above, the putting the patient frequently in hot hip-baths for a quarter of an hour, the occasional passage of a soft catheter, and the rendering the urine alkaline, will give much relief. The urine should always be strained through muslin to collect the *débris*.

It is advisable also to once more thoroughly wash out the bladder with the evacuator a week after the operation, as a safeguard against recurrence from small fragments left behind at the time of operation. Where there is any obstruction, such as an enlarged prostate, Mr. Harrison recommends frequent washings over a prolonged period (*vide supra*, p. 637).

Complications during Lithotrity and Litholapaxy.

1. Escape of Urine.—This may take place during or after the passage of the lithotrite. The penis should be compressed against the lithotrite, and a pause made while the patient is got more fully under the anæsthetic. If this fail, tying a tape round the penis and instrument, injecting a little fluid, or putting off the operation till the bladder is in a more fitting state after the use of instruments, injections, and such drugs as belladonna and subcutaneous injections of morphia, may be made use of. 2. Hæmorrhage.—Sufficient blood to stain the fluid in the evacuator during the operation, and the urine for a day or two after it, is not uncommon. If the hæmorrhage during the operation is severe, the surgeon must decide whether it is due to the damage to the bladder or urethra, to his having scratched the latter by withdrawing a fragment in the evacuator's eye, to bruising of an enlarged prostate, or to co-existent growth. In this last case the supra-pubic operation will probably have to be performed either at the time or later ; in the other cases the surgeon must decide on completing or deferring the crushing by the amount he has already effected, his experience, and the amount of the bruising inflicted. 3. Clogging or Fracture of the Lithotrite.—Clogging or impaction is liable to happen with a non-fenestrated instrument with weak and narrow blades. With one properly made, with as broad blades as possible, and the male one blunt, roughened, and laterally bevelled off, the accident is unlikely. When

it occurs, it must be met by percussing the instrument, if opening and closing the blades, and thus freeing them in the fluid, is impossible. If the impaction persist, the blades must be withdrawn as far as possible by safely maintained traction. If no force that is wise will withdraw them, they should be cut upon in the perinæum, thrust out, unloaded, and withdrawn, and the rest of the stone removed as by a median lithotomy. If, owing to any defect in the instrument, the blades, though not clogged, cannot be screwed up, they must be cut upon as above, thrust through, and, if possible, filed off. If a blade break off, it must either be caught and withdrawn by another lithotrite, or the patient cut at once. 4. Injury to the Bladder or Urethra.

Complications after Litholapaxy and Lithotrity.—These are much the same as those already given at p. 632 as occurring after lithotomy. The chief differences are the greater liability to rigors and urinary fever, and the greater frequency of epididymitis. Bruising of the urethra has also to be remembered, whether by the instruments, or, after the old-fashioned lithotrity, by the passage of fragments.

PERINÆAL LITHOTRITY.

This operation—first suggested and carried out by Dolbeau—consists essentially of lithotrity carried out through a small median or lateral perinæal incision.

Surgeon-Major Keegan (*Brit. Med. Journ.*, vol. ii. 1897, p. 23) observes “that experience has taught that supra-pubic lithotomy has not fulfilled the early promise of the days of its revival, for the mortality which has followed it in cases of very large calculi occurring among males at the middle period of life is very considerable. There is, therefore, a growing consensus of opinion among surgeons practising in the East, where cases of very large calculi are of frequent occurrence, that perinæal lithotrity, whether median or lateral, will in the near future supersede supra-pubic lithotomy in dealing with this very important class of cases of stone in the bladder.” Reginald Harrison (*Brit. Med. Journ.*, Dec. 12, 1896) also recommends the operation, having performed it fifteen times without a death or recurrence. In one case a very hard urate stone, weighing over three ounces, was crushed and removed in about five minutes, an enlarged middle lobe of the prostate being removed at the same time.

Some of the chief points claimed in favour of this operation are: (1) Large stones may be crushed in a short space of time. (2) An enlarged prostate may be dealt with at the same time. (3) It may be performed in cases of stricture or enlarged prostate. (4) It is less severe than the supra-pubic operation. (5) Excellent drainage is provided in cases of cystitis, &c. (6) Digital examination can be made use of to determine whether all the fragments have been removed.

Before it can be decided, however, whether this operation should entirely supersede the supra-pubic operation, further experience must be awaited, particularly with regard to the important question of recurrence.

Operation.—A small median or lateral perinæal incision is made on a grooved staff, as in lithotomy, sufficiently large for the introduction of the finger into the bladder for the purposes of examination. The “giant” lithotrite specially devised by Mr. Keegan (*loc. supra cit.*) is then introduced into the bladder and the stone crushed as in ordinary lithotrity. The fragments may be removed either by means of forceps or an aspirator connected with a specially large evacuating cannula. A tube is then introduced into the bladder through the wound for purposes of drainage.

Mr. Keegan says that the specially strong “giant” lithotrite devised by him, which is of the size of a No. 20 catheter in the stem and of No. 25½ at the angle, “will readily break up a hard calculus weighing six to eight ounces.”

LITHOLAPAXY IN MALE CHILDREN.

The advisability of this mode of treating stone has been strongly advocated by Surgeon-Major Keegan,* who, after a wide experience of large stones in India, is inclined to think that the objections usually made to litholapaxy in boys are not valid. Thus: (1) as to the *smallness of the bladder*, the bladder of a boy of even only three or four is, as a rule, quite roomy enough to permit of the efficient working of a small lithotrite and a medium or full-sized aspirator if gently worked. The bladders of boys with stones are, as a rule, healthy, and will stand more distension proportionately to their capacity than the bladders of old men. (2) *The extreme sensitiveness of the mucous membrane of the bladder and urethra.* Mr. Keegan thinks that, with an anæsthetic, this may be safely disregarded. (3) *The liability to laceration of the mucous membrane of the bladder and urethra.* This objection is, he thinks, a theoretical one only. (4) *The small calibre of the urethra.* Mr. Keegan states that not only is the calibre of the urethra in boys of six or eight not very small, but that of boys of only three or four is sometimes very large. As in men, the true calibre of the urethra cannot be told unless the meatus, which is sometimes very small, is incised. Speaking generally, the urethra of a boy from three to six will admit a No. 7 or a No. 8 lithotrite (Eng. scale), and that of a boy of eight or ten will admit a No. 10, a No. 11, and even sometimes a No. 14. “With a No. 8 lithotrite and a No. 8 evacuating catheter it is, I find, quite feasible to dispose of a mulberry calculus weighing between two and three hundred grains in an hour’s time.”

In a recent publication (*Ind. Med. Gaz.*, August, 1900) Mr. Keegan gives the results of a series of 500 litholapaxies in boys. He says: “Grouping the 500 litholapaxies together, the work mainly of three surgeons, I find that the average age of the boys operated on was six years, the average weight of stone removed at each operation was ninety-five grains, and the stay in hospital after operation amounted to four days. The mortality, as already stated, was 41, or 2·2 per cent.” Of the 500 operations, Mr. Keegan did 239, and lost 5 cases the cause of death being extensive kidney disease. Mr. Keegan had constructed by Messrs. Weiss a No. 3½ lithotrite, which has done very

* *Litholapaxy in Male Children and Male Adults* (Churchill, 1887); *Lancet*, 1886.

good work, and advises anyone wishing to give litholapaxy in boys a fair trial to provide himself with a set of completely fenestrated lithotrites running from No. 4 to No. 10 (Eng. scale).

Mr. Keegan insists upon the completely fenestrated lithotrite as being the only perfectly safe instrument to use, as, with any other, clogging of the blades is a very likely and a most dangerous complication.

In discussing, in the first edition of this book, the advisability of surgeons adopting, as a general rule, this method of dealing with stone in male children, I pointed out (1) that one very important matter, the percentage of recurrence after litholapaxy at this age, had been left undealt with by Mr. Keegan; and (2) that such an individual experience, splendid as it is, can scarcely be taken to furnish a rule to those who only meet with stone at comparatively rare intervals. Mr. Keegan has since written on both these points (*Ind. Med. Gaz.*, February, 1890, p. 40). It will be seen that, with regard to the first point, the fact that recurrence after litholapaxy in boys in India is so very small, is due to the opportunities and experience, absolutely unrivalled and never to be known in this country, which fall to the lot of surgeons in India in treating stone in the bladder. With regard to my second point, that such an individual experience, so different to anything that we meet with here, should not mislead those who only meet with stone at comparatively rare intervals to substitute litholapaxy for the eminently safe operation* which lateral lithotomy has been proved to be in boys, Mr. Keegan, writing as follows, confirms my opinion: "I am disposed to agree with Mr. Jacobson in doubting if in Great Britain lithotomy in male children will be replaced by litholapaxy. And why? Because to render himself familiar with the use of the lithotrite, the surgeon must be afforded frequent opportunities of dealing with cases of stone; and as such opportunities occur only at rare intervals to the majority of hospital surgeons in Great Britain, they will therefore very naturally cling to that operation which is performed by aid of the instrument with which they are most familiar, the scalpel."

Owing to the increasing rareness of calculus in children at the present time, and the fact that, as a rule, isolated cases—and only successful ones—are alone published, it is very difficult to speak definitely about the results of litholapaxy in children in European surgery. I would call the attention of my readers to a paper by Alexandrow (*Deut. Zeit. f. Chir.*, 1891, Bd. xxxii. Hft. 5, S. 6). This surgeon performed lithotomy thirty-two times in boys between 1 and 14 years of age in a children's hospital at Moscow. In twenty-seven the operation was successful; the remainder were fatal, and in three death occurred from injury to the urethra during the operation. Mr. E. Owen, with praise-worthy candour, brought a case before the Medical Society (*Lancet*, vol. i.

* Mr. Bryant, in writing of the successes which lateral lithotomy has given in children (*Surgery*, vol. ii. p. 106), states that during seventeen years 100 patients had been cut consecutively at Guy's without a death. Another matter deserves mention. Cutting for stone is no longer limited, as of old, to a few great centres. How many institutions in or out of London, how many cottage hospitals, will be provided with the set of special instruments which are necessary?

1891, p. 665) in which fatal rupture of the bladder had taken place during litholapaxy in a boy aged 4. Litholapaxy is risky in children, and entails the presence of special and expensive instruments, and always at any age, may risk, must risk, leaving the last fragment, which may lead to recurrence.

TREATMENT OF STONE IN THE BLADDER IN THE FEMALE.

Practical Points.—The absence of any prostate or of a fixed smooth trigone-surface is of importance here, especially with regard to lithotripsy. The aid given by a finger in the vagina, the dilatability of the urethra, the association of calculi with foreign bodies, are also well known. It is only occasionally that enlargement of the uterus or prolapse of the vaginal wall of the bladder interferes with the treatment of stone.

Operations.

A. In Adults.—We have here the following three methods to consider :

1. **Dilatation.**—When the stone is small—*i.e.*, the size of a filbert, a stone not exceeding three-quarters of an inch in its largest diameter—it may be safely removed after rapid dilatation with Kelly's dilators, followed by a finger (the little one first).

It is not meant by this that much larger stones have not been successfully passed and removed from the female bladder. Thus, Dr. Yelloly (*Med.-Chir. Trans.*, vol. vi. p. 574) gives a case in which a stone, weighing 3 oz. 3½ drs., was extracted: incontinence followed. Where large calculi—*e.g.*, of 6 oz.—have come away spontaneously, it has been usually by a process of prolapsus and ulceration combined. We do not yet know what is the greatest dilatation which the female urethra will safely bear. Perhaps the limit given above is, if anything, too small. Erichsen (*Surgery*, vol. ii. p. 1024) gives "8 or 10 lines in diameter" as the size of a stone which can be safely extracted by this means. Sir H. Thompson (*Syst. of Surg.*, vol. iii. p. 308) says, "dilatation should never be employed for any calculus larger than a small nut or a large bean in an adult, which limits its application to very few cases." Mr. Bryant (*Surgery*, vol. ii. p. 120) states that, "in children, a stone three-quarters of an inch in diameter, and in adults one inch, may be fearlessly removed from the bladder by rapid dilatation and extraction, with the patient under the influence of chloroform. I have removed larger calculi, two inches in diameter, by this means, without any injurious after-effect, but it is probably not wise to make the attempt, the surgeon possessing in lithotripsy an efficient aid or substitute." Dr. Keyes (*Intern. Encycl. of Surg.*, vol. vi. p. 297) recommends not dilating the urethra more than three-quarters of an inch.

2. **Litholapaxy.**—By this means calculus in the female bladder may be most frequently and efficiently treated. Thus, hard stones under an ounce, and phosphatic ones of a much larger size, may be dealt with at one sitting. The character of the ring or sound with the staff, the bite of the lithotrite, the cystoscope, and the condition of the urine will aid here. A shorter instrument will be found much more convenient to work with. Where there is much irritability of the bladder, much

difficulty will be met with in keeping fluid in it, owing to the absence of a prostate and the shortness and directness of the urethra. The pelvis must be well elevated, the patient placed fully under the anæsthetic, and the finger of an assistant should make pressure on the urethra. In other respects the operation resembles that already fully given for the male (p. 637). The dilatable urethra admits a full-size evacuating tube.

3. **Lithotomy.**—This operation is called for when the stones are multiple,* when one is large, especially if mainly hard as well, when there is a foreign body as a nucleus,† when there is great irritability with ulceration of the bladder, or when a growth co-exists.

Of the following methods—(a) vaginal, (b) supra-pubic, (c) urethral, and (d) the lateral method of Buchanan—the first two only need be alluded to.

Vaginal Lithotomy.—By this is meant extraction of a stone through an incision in the anterior vaginal wall, behind the vesical orifice of the urethra, and thus not interfering with this canal at all.

This anterior wall is about four inches long in the adult; in relation with it anteriorly is the urethra, to be felt as a cord through this wall, behind this the bladder, and farther back the os and cervix uteri. No peritonæum is normally in relation with this wall, as this membrane leaves the uterus half-way down to pass directly on to the bladder. No important vessels or nerves are met with in vaginal lithotomy; but this, though the simplest and easiest of all the methods of cutting for stone, will be but rarely called for, as in all moderate stones in women, litholapaxy is usually available, while in the case of larger ones, and with all calculi in female children, the supra-pubic method is indicated, save for tiny stones which can be removed after dilatation. The only drawback of a vaginal lithotomy in women is the risk of a fistula, but this need only be taken into account where phosphatic urine is present, or where the edges of the wound have been bruised during the extraction of the stone. In either case the calculus will probably be a large one or multiple, a condition, as already stated, which is better dealt with otherwise. The following case, which came under my care in 1889, is a good instance of how the operation may be occasionally called for:

“Vaginal Lithotomy in a Patient Six Months and a Half Pregnant; Immediate Suture of the Wound—Recovery; Normal Delivery at Full Time” (*Lancet*, vol. i. 1889, p. 628). A. L., aged 27, was sent to me by Dr. Montagu Day, of Harlow, December 7, 1888. For three years she had had bladder trouble—viz., hypogastric pain, cystitis,

* As in Dr. Galabin's case (*Obst. Soc. Trans.*, April 7, 1880), in which twelve large calculi and about fifty smaller ones were removed successfully by vaginal lithotomy from the bladder of a woman aged 61

† As in the large stone formed round a hair-pin, and figured (p. 579) by Hart and Barbour in their *Manual of Gynecology*. Here the projection of the hair-pin on either side of the stone would indicate, nowadays, the supra-pubic operation. I have alluded to a similar case in my practice at p. 629. Some of my readers may remember that a few years ago an inquest was held in London on the body of a girl who died with an undetected calculus in the bladder, which dated to a hair-pin. The sarcastic remarks of the coroner led to some correspondence in the papers, from which it would appear that these calculi are less rare than has been believed.

very frequent micturition day and night, with stoppages of the stream, and acute suffering after the bladder was emptied. The patient was extremely timid and nervous, owing to her four confinements having been "tight" and lingering. Craniotomy had been required with the first, and, with another, labour was induced at seven months.—December 8. The urethra was dilated, and the bladder explored. A calculus, apparently an inch in either diameter, was felt; the bladder was extremely contracted with its mucous membrane in places raw and bleeding, in others encrusted with phosphates. It was decided, for the reasons given below (651), to perform vaginal lithotomy.—December 10. Twenty-four hours after the exploration the patient had recovered control over her bladder. The vagina was thoroughly syringed out with hydr. perch. (1 to 1000), the posterior wall was well drawn down with a duckbill speculum. A straight lithotomy staff (No. 4) was then passed, and the site of the stone determined. A sharp hook was next inserted into the posterior part of the urethra so as to drag the anterior wall of the vagina upwards and forwards. This, however, caused such free oozing that it had to be removed, and sponge-pressure applied. The bleeding was partly caused by the vascularity of the parts due to pregnancy, and partly by that set up by the dilatation of the urethra two days before. A sharp-pointed bistoury, introduced so as to avoid the urethra and neck of the bladder, was carried into the groove of the staff through the anterior wall of the vagina and fundus of the bladder, and then backwards for nearly two inches. The gush of urine which at once followed on the withdrawal of the knife carried the stone downwards, and it was extracted with lithotomy forceps with the utmost ease. After the bladder had been explored with the finger, it was repeatedly washed out from the wound* with diluted Thompson's fluid. Little bleeding had followed on the incision, and it was clear that sutures would entirely control what remained. The vagina having been well sponged out, the edges of the incision, clean cut and without bruising† were adjusted with six salmon-gut sutures and four of horse-hair. The apposition was tested with a fine probe, especially behind, where a little difficulty was met with in inserting the sutures. Owing to the patient's straining at this time, some urine escaped from the urethra, but none came through the wound. The vagina was next thoroughly syringed with a solution of hydr. perch. (1 in 3000), dried out with aseptic sponges, and dusted with iodoform. To secure more certain asepsis, and also to support the wound and sutures, the vagina was lightly plugged with strips of iodoform gauze. Though this was done with all gentleness, it was soon after noticed that blood was trickling from the vagina. On removal of the strips, two small lacerations on the right side of the vagina, near the orifice, the parts here being exceedingly pulpy and vascular, were oozing freely. This was arrested by tying up the bleeding points with chromic gut. The vagina was again irrigated and insufflated, but no further trial of plugging was made. As soon as the patient was replaced in bed, a soft catheter was inserted to empty into a "slipper." The recovery was rapid and without drawbacks. The ten sutures were removed on the eighth day with the aid of chloroform. The catheter was retained till the twelfth day, when the patient was allowed to get on a sofa. She left the hospital seventeen days after the operation. Dr. Day wrote, on March 19, that the patient had been safely confined without any trouble with the lithotomy incision.

The first question to decide here was whether to operate at once or to let the pregnancy (already advanced to six months and a half) be first concluded. While the stone itself was not large enough to have interfered with labour, both Dr. Day and I thought that, if the bladder were allowed to remain in its present state for another two months and a half, the cystitis would be rendered much more difficult of treatment, intensified, as it was likely to be, by a lingering and difficult confinement, such as the patient was liable to. It having been decided that

* It would be wiser to do this from the urethra.

† Under less favourable conditions closing the wound may have to be deferred till the parts are quite healthy.

it was advisable to interfere at once, the choice lay between (1) *dilatation of the urethra*, (2) *litholapaxy*, and (3) *lithotomy*. (1) *Dilatation*.—The size of the stone at once put this aside. Though small (240 gr.), it was a full inch in one diameter, and just over three-quarters of an inch in the other. With such a stone (a hard one, of lithic acid and lithates), there was a very serious risk of after-incontinence (especially when the blades of a small forceps have to be taken into consideration as well). (2) *Litholapaxy*.—If it had not been for the co-existing pregnancy, the stone might well have been thus dealt with. But as great irritability of the bladder was present, in addition to the pregnancy, it was thought that litholapaxy was more likely to require a prolonged anæsthetic and to cause greater disturbance of some important pelvic and abdominal viscera than the remarkably simple and rapid vaginal lithotomy. It will be remembered that the way in which the anæsthetic would be taken, and its after-results, were more than ever matters of uncertainty in this case. If the anæsthetic had been badly taken, we had to face the risks, on the one hand, of premature labour coming on, and, on the other, of difficulty in completing the operation, and thus of fragments being left behind, which would intensify the already existing cystitis. (3) *Lithotomy*.—It being decided to resort to this, the vaginal method was chosen from its great simplicity, the small amount of anæsthetic required, and the facilities which it gave for washing out the bladder at the time of the operation.

Supra-pubic Lithotomy.—This has been fully described at p. 623. The fluid is retained in the bladder by finger-pressure upon the orifice of the urethra.

B. *In Children*.—Some of the conclusions which Mr. Walsham has drawn in a very helpful paper (*St. Barthol. Hosp. Reports*, vol. xi. p. 129) may be quoted here :

For small stones rapid dilatation under chloroform is better, as causing less annoyance and inconvenience to the patient. That moderate and even large-sized stones have been removed by dilatation, but that, as incontinence has frequently followed from over-distension, it is not justifiable to subject the patient to this risk. That, after limited dilatation, should the stone appear larger than was anticipated, it may be crushed with safety ; but, should crushing be considered unadvisable or impossible, it is better to perform vaginal lithotomy than subject the patient to any risk of incontinence by over-dilatation. That it is not safe to aid the dilatation by incising the urethral walls. That incision of the urethra alone, without dilatation, in whatever direction practised, is frequently attended with incontinence, and should therefore be abandoned. That moderate and even large stones can be easily removed from young children by vaginal lithotomy, aided, if necessary, by dilatation of the vagina, incision of the fourchette, and crushing of the stone by the wound made through the septum, without any risk of a permanent vesico-vaginal fistula so long as the edges of the incision are not bruised in the extraction.

Mr. Walsham considers each of the above and several other points separately, and supports them with evidence. I think that this tends to show, in the case of vaginal lithotomy, that, though a stone may be thus extracted after dilatation of the vagina, division of the fourchette,

and destruction of the hymen, it is by no means easy in these cases to insert sutures satisfactorily. It will be wiser, I think, to make use of the supra-pubic operation in female children for all save the very smallest stones. Litholapaxy, although by no means easy in these small bladders is, however, held by Mr. Keegan (*Ind. Med. Rec.*, Aug. 1, 1897) to be the correct treatment in the great majority of cases of vesical calculus in women and girls.

I would refer my readers to a case of supra-pubic operation by Mr. Barwell in a child, aged 9, from whom a stone weighing two and a quarter ounces was successfully removed. It is interesting to note that Mr. Barwell was led to adopt the supra-pubic operation from his having had within seven months no less than three cases of vesico-vaginal fistulæ originating in the extraction of calculi during infancy and youth by different surgeons (*Med.-Chir. Trans.*, vol. lxi. p. 342).

CYSTOTOMY.

Indications.—The operation of opening the bladder, apart from such cases as exploring for growth, foreign body, &c., may be required in:

(1) Some cases of cystitis. When the urine is foetid and slimy. When pain in the bladder and penis is intense, leading to loss of sleep and appetite. When there is a high temperature and other evidence of imminent septicæmia. When all other treatment has failed; and when washing out is insufficient or unendurable.

The operation here, for the sake of the kidneys, must not be put off too late. Much benefit may be obtained by irrigating the bladder freely, and afterwards mopping it out with a small sponge and a solution of silver nitrate, 3ss or ʒj—ʒj.

2. Some cases of tubercular cystitis (p. 610).

3. As part of other operations. Thus, in plastic operations about the urethra, to keep the parts dry, the bladder may be opened. I have done this in a case of epispadias.

4. As a palliative measure, for the relief of obstruction from enlargement of the prostate.

Supra-pubic cystotomy for drainage of the bladder. A helpful account of this method is given by Mr. Bond (*Lancet*, vol. ii. 1889, p. 260). The distended bladder having been incised above the pubes in the ordinary way, the urethral orifice is felt for with the forefinger, and a curved staff passed until it bulges in the perinæum just below the bulb. The patient being placed in lithotomy position, the point of the staff is cut down upon, pushed through, and a rubber tube attached to it. This tube, with one or two openings in it, is drawn through above the pubes. In a few days it may be drawn into the bladder from below, and a little later withdrawn altogether.

Where the supra-pubic and perinæal incisions have been made use of for a stricture which cannot be dilated from the front, the curved sound is removed as soon as the perinæum has been opened, and the stricture thoroughly divided. A grooved director is then passed from the perinæum into the bladder, and upon this, as a guide, a full-sized catheter is passed from the urethra into the bladder and tied in. See a case of traumatic stricture thus treated by Sir Henry Howse (*Clin. Soc. Trans.*, vol. xii. p. 9).

The above are instances of cases calling for cystotomy. The surgeon will have to choose between three operations—viz., median and supra-pubic cystotomy and external urethrotomy. The median operation is almost always to be preferred to the lateral, but it is probable that external urethrotomy (Ch. xiii.) will be sufficient in most cases as to drainage, and it is certain that this operation is less risky from shock, cellulitis, and secondary hæmorrhage. The great object is to drain the cavity thoroughly.

RUPTURE OF THE BLADDER.

This used to be a most fatal accident, thus out of 143 cases of intra-peritonæal rupture collected by Ullmann in 1886, only two recovered; and only 20 out of 94 cases of extra-peritonæal laceration got well (von Bergmann, vol. v. p. 452).

The late Sir William Mac Cormac* was the first to publish two successful operations for intra-peritonæal rupture (*Lancet*, 1886, vol. ii. p. 118). He attributed his success to the careful use of Lembert's sutures, instead of piercing the whole thickness of the bladder wall, including the mucous membrane, as had been the usual practice up to that time. Many successful operations have been recorded since then. Alexander† and Jones‡ collected 54 cases of intra-peritonæal rupture, with a mortality of 63·5 per cent. after 32 operations before 1893, and 27·5 per cent. after 22 operations performed since 1893.

Ashhurst (*Amer. Journ. Med. Sci.*, July 1906) has collected 110 cases with 63 recoveries, and 47 deaths, a death rate of 42·72 per cent.

Quick (*loc. supra cit.*) adds to Jones's 22 cases, treated since 1893, 7 more recent ones, and out of these 29, only 7 died, a mortality of 24·1 per cent. These figures are probably too favourable, for successes are generally published, whereas the more instructive failures are too often forgotten.

Exploratory operations and suture of the bladder will be increasingly successful in favourable cases—*i.e.*, those seen early and those in which the injury is limited to the bladder.

Two forms of rupture are recognised—the intra- and extra-peritonæal, but, in some cases, the tear extends to both the intra- and the extra-peritonæal surfaces, and occasionally two lacerations may co-exist, and one of them is very likely to be overlooked. It may be well to state succinctly the symptoms.

Intra-peritonæal Rupture.—(1) History of a likely injury. (2) Inability to pass water.§ This power has, however, been preserved in both varieties: naturally it is seen most frequently and more completely in extra-peritonæal cases. It is very rarely normal in the intra-peritonæal ruptures. Attempts at micturition may be frequent and

* Many others have followed. Mr. Walsham has been able to report two successful cases (*Trans. Med.-Chir. Soc.*, 1886 and 1895).

† *Ann. of Surg.*, 1901, vol. xxxiv., p. 209.

‡ *Ibid.*, 1903, vol. xxxvii., p. 215.

§ Thus the rent may be valvular or blocked by intestine, &c. On all these and many other points the reader should refer to Mr. Rivington's writings, *Diet. of Surg.*, vol. i. p. 152, and *Rupture of the Urinary Bladder*, for exhaustive completeness and helpful information.

painful, but only blood-stained fluid may be voided in small quantities. (3) A little bloody urine drawn off with a catheter. (4) Difficulty of manipulating an instrument in a contracted bladder. (5) If the catheter, hitting off the rent, be passed beyond the bladder, a much larger quantity of blood-stained fluid is withdrawn, partly urine, partly serum, from irritation of the peritonæum. If the flow through the catheter is markedly increased by inspiration and diminished by expiration, the rent is probably a large one.

(6) Shock. This may be absent or pass unnoticed in patients who are intoxicated at the time of the accident, and as the laceration frequently occurs under these circumstances, this fact is important to bear in mind.

This form of rupture commonly follows a kick or a blow upon the abdomen, when the bladder is distended, but it has also occurred spontaneously during the retention of urine from stricture, enlargement of the prostate, or any other obstruction. The accident has also occurred during the crushing of vesical stones and in the course of perinæal operations upon the bladder; Bottini's galvano cautery has opened the peritonæum a good many times during the attempt to cauterise the enlarged prostate in the dark.

(7) Speedy supervention of signs of peritonæal irritation, viz.:—pain in the lower part of the abdomen, tenderness and rigidity. The surgeon should not wait for the classical signs of peritonitis to manifest themselves. Dr. Quick records a case in which no peritonitis had developed after 10½ days. The patient, who was intoxicated at the time of the accident, was able to work on the following day, but he had to leave off on the second day on account of pain and vomiting. He recovered after an operation, performed on the eleventh day by Dr. G. F. Thompson (*Ann. of Surg.*, January, 1907, p. 94).

In other cases, in which the urine has been aseptic and no instruments have been passed, the onset of peritonitis has been considerably delayed.

(8) Perhaps fluctuation and shifting dulness in the flanks, with abdominal distension.

Extra-peritonæal Rupture.—This is often due to or associated with fracture of the pelvis, but it frequently happens when no such fracture exists. It has followed repeated supra-pubic aspiration. (1) History of a likely injury. (2) Inability to pass water (*vide supra*). (3) A little bloody urine drawn off. (4) The catheter finds the bladder contracted. (5) No tapping of a larger amount of fluid. (6) Evidence of extravasation rather than of peritonitis. Thus, if the rent is in front, the urine may be localised there with circumscribed dulness; or widely diffused, mounting up towards the umbilicus, between the abdominal muscles and the peritonæum; or passing into the iliac fossæ, or, by the canals, into the scrotum and thighs. In one case that I saw the extravasation was much more extensive upon the right side so that the situation of the rent was correctly diagnosed to be upon this side. In another patient, the late Mr. Davies-Colley localised the position of the extra-peritonæal rent, which was due to a fracture of the pelvis, by the inability of the boy to flex and adduct his right thigh; vertical fractures through the right rami were found at the operation. The patient soon becomes very ill, with a quick pulse and respiration, probably from

reabsorption of urine from the connective tissue; these symptoms appear while the extravasation is still sterile, but sooner or later infection is bound to follow.

It must be remembered that the following may mislead: There may be very little pain complained of; no sickness; a normal temperature; the patient may be able to walk; upwards of half a pint of urine may be drawn off night and morning, and yet the peritonæal sac may contain much fluid. Peritonitis may be absent post-mortem, though tympanites be present during life, and though fluid be found in the peritonæal sac. The patient may live as long as five days, apparently improving, and then die suddenly.

The following may be useful in doubtful cases:

Mr. Walsham in his second case (*Trans. Med.-Chir. Soc.*, vol. lxxviii. p. 278), to make certain of the existence of a rupture, made use of the injection of air, the injection of fluid not being conclusive. "For this purpose the india-rubber apparatus belonging to an ether-freezing microtome was utilised, the tube of which was attached to the free end of the catheter. The liver dulness having been carefully percussed out, a few cubic inches of air were forced through the catheter by two or three contractions of the rubber ball. The effect was instantaneous. The abdominal cavity became distended, the liver dulness immediately effaced, and the whole abdomen tympanitic to percussion. The patient fell into a condition closely resembling collapse; he complained of great pain, his respiration was laboured, and the action of the heart turbulent."

This method was recommended by two American surgeons, Dr. Morton and Professor Keen, independently, in 1890. Mr. Walsham was the first to employ it. The cystoscope is not likely to be of much use except in the extra-peritonæal injuries, owing to the difficulty of keeping fluid within the bladder in the intra-peritonæal ruptures.

Operation.—This must be undertaken without delay. The patient being under an anæsthetic, the abdominal wall cleansed and shaved, and the parts relaxed,* a free incision five or six inches long in the adult, is made near the middle line. The rectus sheath having been divided, the rectus drawn outwards and partly detached if needful, all bleeding points secured, the lower angle of the wound and the parts behind the pubes are carefully examined for ecchymosis, extravasation, &c. If neither of these nor any collection of fluid is found outside the peritonæum, this is opened, when a large gush of fluid may be decisive. The surgeon now introduces one finger to feel for the rent, and the detection of this may be facilitated by passing a short-beaked sound. The rent will vary in site and length,† and also as to regularity, thickening, &c. If it be a long one, and reach downwards towards the recto-vesical cul-de-sac, the Trendelenburg position should be adopted. This gives valuable assistance, for it grants a good view of the posterior surface and affords plenty of room for the introduction of sutures

* In Mr. Willett's case (*St. Barthol. Hosp. Reports*, vol. xii. p. 209) much difficulty was met with from the rigidity of the abdominal walls, and the great distension of the intestines, which kept crowding out of the wound, and were most difficult to replace. Peritonitis had set in here, twenty-four hours having elapsed since the injury.

† In Sir W. Mac Cormac's cases the rents were four and two inches long.

without risk of injuring the small intestines, which fall away and are protected with a sterile pad. Sir W. Mac Cormac also found that the bladder came up more readily after the parietal peritonæum had been transversely divided on each side. An assistant may render service at this time by grasping the upper end of the bladder and drawing it forwards and a little to one side while the intestines are kept back with gauze tampons if the Trendelenburg posture has not been adopted. The rent, being now in view, is cleansed, and sutures of fine sterilised silk inserted. The shortest possible needle should be employed here, owing to the depth of the wound and the limited space there is to work in. Mr. Walsham in his second case found that a T. Smith's rectangular palate-needle answered admirably in inserting the deepest sutures. All of these should be put in before any are tied, and if the first are gently drawn upon it will facilitate the insertion of the others.* Sir W. Mac Cormac used sixteen sutures in one case and twelve in another, and his success is largely due to the great care with which they were inserted. Thus, they were put in a quarter of an inch apart, after Lembert's method (Fig. 99, p. 353), including the serous and muscular coats only, beginning at the lower part, the first and last sutures being inserted well beyond the limits of the injury so as to prevent leakage from the extremities. Silk is the best material to use for catgut may give way prematurely, and as the silk does not pierce the mucosa there is little danger from its use. Reliable catgut which will last over a fortnight may be used if preferred. The following precautions are taken in suturing: Fine curved needles are used in holders; the serous surfaces are carefully inverted. The anterior or superior end of the laceration should be sewn first, and the ends of each suture left long, so that gentle traction upon them may facilitate the introduction of the inferior stitches (Jones, *loc. cit.*). The sutures are passed through the serous and muscular coats only. This avoids the risk of traversing the mucous membrane, which in animals has nearly always proved fatal, because—(1) on tightening the sutures, the mucous membrane falls between the edges of the wound and hinders union; (2) the urine may find a channel through the points of passage of a suture, and so into the cavity of the peritonæum; (3) the loop of suture within the bladder is a foreign body, and salts may be deposited on it.

Wherever a gap appears, another suture should be inserted. All the ends are now cut short. If there is time, a continuous suture may be used to reinforce the first row,† but Sir W. Mac Cormac regards the double row as unnecessary. In one case I used interrupted catgut for the deep row and a continuous silk for fortifying and burying this. It is not wise to inject coloured liquid into the bladder with the view of testing the stitching, for this is unnecessary if proper care be taken, and the Trendelenburg attitude adopted. Moreover it wastes time, which is better given to careful suturing. The peritonæal cavity is now

* In this case the rent was in the posterior wall extending from the summit along the middle line to the base of the trigone.

† Sutures through the serous coat only invariably give way.

most carefully wiped out with gauze pushed well down into the pelvis and the flanks till they come out clean and dry on squeezing.

Where the surgeon is doubtful about the state of the peritonæal sac, a fenestrated rubber tube containing a wick of gauze* should be left in the pelvic pouch. A drain should be left in the pre-vesical space in extra-peritonæal ruptures, especially if the operation has been deferred until it is difficult or impossible to find or suture the rent satisfactorily. A catheter should be tied in, care being taken not to pass too much of it into the bladder, but to leave the eye only just above the vesical orifice. The bladder must not be allowed to get full, either from slipping or blocking of the catheter.

Cases occasionally occur where the neck and not the body of the bladder is lacerated, a fracture of the pelvis perhaps co-existing. Where there is inability to pass water and where it is uncertain whether a catheter enters the bladder, it will be best to explore the front and neck of the bladder by a supra-pubic incision not opening the peritonæum. If blood-stained fluid well up, and if the catheter be detached lying outside the bladder, the bladder should be opened and a curved staff passed through the urethra and cut down upon in the perinæum. A drainage-tube should then be passed according to the directions given at p. 652.

This will drain the bladder effectually, and prevent any further escape of urine. The space outside the bladder, around its neck, must be cleaned thoroughly by the supra-pubic incision, tamponnaded with iodoform gauze, and, if needful, drained from the perinæum.

In late cases with pelvic cellulitis free incisions must be made and drainage established.

Causes of Death.—Peritonitis, shock, hæmorrhage, cellulitis.

Peritonitis is far the commonest cause of death, and it may be due to infection from previously infected urine, or from careless instrumentation, from infection at the operation or subsequent leakage due to inefficient suturing.

PUNCTURE OF THE BLADDER.

The following methods will be considered here :

i. **The Aspirator.**

ii. **Supra-pubic Puncture.**

i. **The Aspirator.**—This may be used in cases of great urgency, when the surgeon is compelled to relieve retention without regard to the cause, when he is without the means of carrying out other and perhaps better methods ; it is especially suited to those cases in which there is reason to believe that urine will again, in a few hours, be passed by the urethra. Thus in gonorrhœal retention, where a catheter cannot be passed, having perhaps been clumsily used, and where relief is urgently required, where retention has supervened on a stricture of only two or three years' standing, this means may be used successfully, giving time for warm baths and opium to act. In an old stricture, in one of traumatic origin, or in a case of enlarged prostate, it can only

* Mr. Betham Robinson (*Lancet*, Jan. 23, 1904) records a recovery from an intra-peritonæal rupture of the bladder in a girl of only 5 years of age.

be a temporary measure, and should only be used when other instruments are not available.

The question arises, *How far will aspiration bear repetition?* This is quite uncertain. On the one hand, in a case of prostatic retention not admitting a catheter, the patient being throughout in a most grave condition, Dr. Brown (*Brit. Med. Journ.*, May 23, 1874) used the aspirator fifteen times between January 2nd and 12th, "with immediate relief on every occasion, and without the smallest inconvenience or injury from the punctures." Mr. Hague (*Lancet*, 1885, vol. ii. p. 385) in a patient aged 90, with prostatic retention of forty-eight hours' duration, aspirated, and continued to do so daily for nearly five weeks, as no catheter could be passed. Such numerous aspirations caused no ill effects.

On the other hand, in a case of mine of prostatic retention in which the aspirator had been used only three times, on the death of the patient from bronchitis on the fourth day the third and last puncture was found to be leaking. Dr. Campbell (*Brit. Med. Journ.*, Feb. 21, 1886) records a case in which the bladder had been aspirated twice, and internal urethrotomy then performed. "Progress was good for a day or two, when some inflammation appeared at one of the punctures, an abscess formed, peritonitis came on, and the man died." Where aspiration is to be used, the condition of the bladder walls and of the urine must be taken into account.*

If aspiration be made use of, a fine needle should be employed, and introduced just above the pubes while an assistant steadies the bladder by pressure on either side. The bladder must not be allowed to become much distended before the puncture is repeated, otherwise urine may be forced out.

ii. Supra-pubic Puncture.—This operation has the *advantages* of being easily performed, of giving permanent relief if desired, and of being safe.

The two *objections* brought against it are—that (1) it gives bad drainage, and (2) it is liable to extravasation.† Neither of these is borne out by facts. While the patient is in bed, good drainage can be provided by turning him on one side and attaching tubing to the cannula; when the patient is up (and a cannula so placed is no drawback to this), the power of micturition will probably have returned. In a few cases of enlarged prostate the patient will be compelled to pass his urine this way for the rest of his life, but as soon as the parts are consolidated around the cannula, or the catheter which has replaced the cannula, micturition, though tedious, will be effected satisfactorily.

I may allude to three cases out of many in which I have used this method, two of retention with stricture, one of prostatic retention. I consider it the best all-round method, and the one of widest application that we have. Its relief is immediate, safe, and simple withal. The two cases of stricture were men under 40, admitted with a history of catheterism, bleeding urethræ, and recent false passages. On the

* Mr. Bennett read a case before the Medico-Chirurgical Society (*Lancet*, 1888, vol. i. p. 418) of extra-peritoneal rupture of the bladder after aspiration in a patient long the subject of stricture. The opinion of most surgeons present seemed to be that aspiration was dangerously liable to leakage, especially in unhealthy bladders.

† Mr. T. Smith (*St. Barthol. Hosp. Reports*, vol. xvii. p. 291) writes: "I have seen no such tendency to extravasation; occasionally there is some inconvenience from leakage: this may be met by leaving out the cannula for a few hours, which allows recontraction to take place."

fifth and second days I was able to pass a No. 7 silver, and in the third case a coudée, catheter. For some cases of older strictures, especially if with fistulæ and a damaged perinæum, a longer rest is required, and Mr. Cock's or Mr. Wheelhouse's operation is indicated.

Operation.—This is most simple, and eucaïne (℥ xx—ʒj of a 5 per cent. solution) can be injected to prevent any pain. A median puncture having been made with the knife through the skin just above the shaved pubes, the trocar is inserted. I prefer a curved trocar and cannula, the latter carrying tape-holes, but a straight trocar and cannula may be used, through which an 8 or 9 gum-elastic catheter, or better, a Jacques' catheter, is inserted; in four hours the cannula can be removed, and a large catheter, a 10 or 12, introduced.* To keep the cannula firm at first, I insert a suture in the puncture, cover this with iodoform and collodion, and pack some strips of dry gauze around. Colt's supra-pubic drainage apparatus may be used to keep the patient dry.

Puncture per rectum has been properly abandoned, because it was attended with serious dangers, and was, moreover, very unpleasant. The retro-vesical pouch of peritonæum has been opened, and the trocar has been passed into the prostatic urethra without affording relief. Severe cystitis and ascending nephritis sometimes ensued.

* If an aspirator has been used, and it is desired to replace it with a catheter, a catgut bougie should be passed through the cannula, and, this being withdrawn, a small gum-elastic catheter, with an eye in its point, is passed over the bougie. Larger ones can soon be got in, passing them with terminal eyes over the smaller ones, or by means of a stylet (T. Smith).

CHAPTER XII.

OPERATIONS FOR DISEASES OF THE PROSTATE.

THE TREATMENT OF ADENOMATOUS ENLARGEMENT, OR SO-CALLED SENILE HYPERTROPHY—MALIGNANT DISEASE—PROSTATIC ABSCESS—PROSTATIC CALCULI.

ENLARGEMENT OF THE PROSTATE—ANATOMICAL AND PATHOLOGICAL CONSIDERATIONS.

THE human prostate is formed by the fusion of bilateral accessory sexual glands, which remain separate in lower animals. The normal organ weighs $4\frac{1}{2}$ drachms upon an average, but it is subject to considerable variation, and prostates weighing as little as 2 or as much as 6 drachms may be quite normal. As a rule obstruction does not arise until the gland is much larger than this, but occasionally quite small enlargements, especially of the hard or fibroid type, may make a patient entirely dependent upon a catheter, the fibroid contraction, with or without local outgrowths into the urethra, serving to interfere very seriously with the size and shape of the passage.

The effect of any given enlargement also depends very largely upon the rigidity or laxity of the fascial sheath of the prostate, and upon the presence of any local outgrowths into the urethra or bladder.

Prostates weighing no more than three-quarters of an ounce have caused complete and permanent obstruction, while in others the obstruction has not become serious until the soft gland has reached enormous dimensions, and has attained the weight of 5 or 6 or even more ounces.

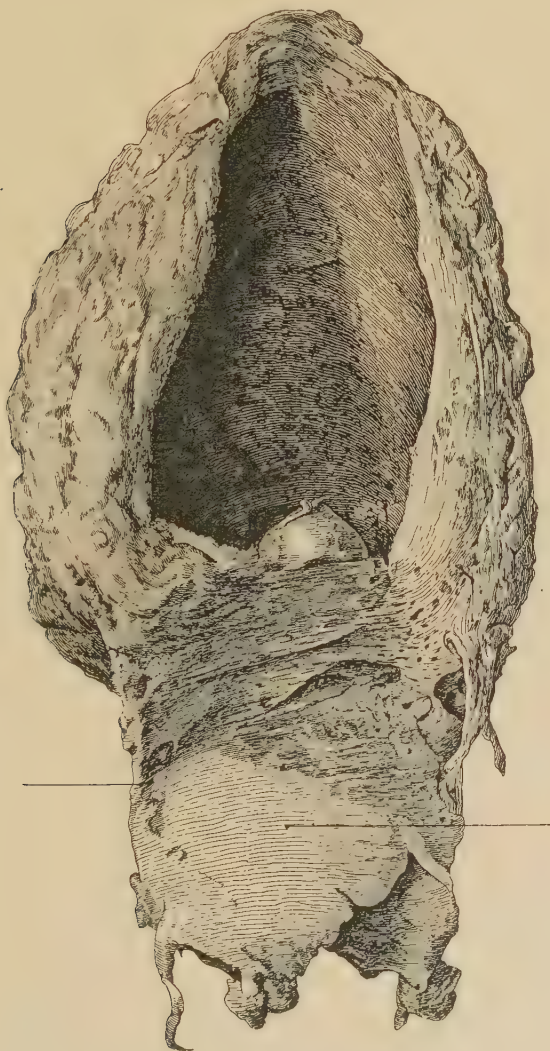
It is important to remember that the prostate is (1) enclosed within a *true fibro-muscular capsule*, and (2) surrounded by an *external fibrous sheath* derived from the pelvic fascia (*vide* Fig. 256, p. 671).

In the normal condition the capsule is intimately attached to the gland, so that it is practically impossible to enucleate the latter from within this covering. In the enlarged prostate, however, things are very different, for a laminated and thicker pathological capsule now surrounds the adenomatous gland. This is derived from the fibro-muscular tissue and other parts of the prostate, which have not taken a share in the adenomatous change and have become displaced outwards by the growth, as pointed out by Mr. Cuthbert Wallace (*loc. infra cit.*).

The enlarged prostate is enucleated from within this pathological capsule, or the separation takes place between some of the laminae, so that thin layers of fibres are often seen encircling the prostate, when

the latter is removed in one piece (*vide* Fig. 255). Very little bleeding need occur when the pathological capsule has formed, and when the operator keeps within the proper layer.

FIG. 253.



The bladder and the prostate. The attachments between the fibrous sheath and the true capsule are so intimate that enucleation would be very difficult or impossible. (Watson, *Ann. of Surg.*)

(2) The fibrous sheath is derived from the pelvic fascia. The external layers of this are very dense, but towards its inner surface it is less firm, and harbours the prostatic plexus of veins. Mr. Freyer maintains that the enucleation is performed between the sheath and the capsule.

As pointed out years ago by Sir Henry Thompson, there is no such thing as an anatomical or a physiological middle lobe; it is a pathological product, and is generally, if not always, a process derived from one or other or both of the lateral lobes. The vesical projection is usually most evident just behind the vesical orifice of the urethra, and on the middle line, because of the directing influence of the muscular bands which extend down to the urethra from the ureteral ends, as pointed out by Mr. Thompson Walker (*Royal Med.-Chir. Trans.*, 1904, p. 404).

The fact that the so-called median lobe is merely a prolongation from the lateral lobes is of the highest significance, for it is clear that removal of the vesical projection is not liable to grant permanent relief, for the prostate, which has produced an offshoot, is more than likely to go on growing, and to obstruct the urethra by lateral compression sooner or later. Below, the fascial sheath is attached around the urethra to the triangular ligament, which offers a strong and impassable barrier to the enlarging gland, which therefore projects upwards towards the base of the bladder, where the sheath is incomplete. Submucous processes therefore project upwards, by the side of the vesical orifice, and between this and the circular fibres which surround it and form one of the sphincters of the bladder. The sphincter constricts the base of the vesical projection, so that the greatly enlarged prostate often assumes the shape of an hour-glass. It is probable that the fibrous ring formed by the attachment of the lateral and anterior true ligaments of the bladder to the neck of the latter also exercises an influence in the same direction upon the shape of the enlarged prostate. From near the vesical neck the true ligaments become reflected downwards to form the dense fibrous sheath of the prostate, and upwards in a thinner layer which becomes lost upon the bladder, to the lower part of which it forms a fibrous covering. When the enlarged prostate is enucleated, the separation should always take place within the fibrous sheath, and also within at least a part of the pathological capsule. In this way the prostatic plexus of veins is not opened, and the risks of severe hæmorrhage and phlebitis are minimised. The pelvic cellular tissues are not opened, so that cellulitis of the delicate and loose tissues which surround the bladder and the other pelvic viscera should not occur if the operation is properly conducted well within the fibrous sheath. This tissue is, however, opened in exposing the bladder in the supra-pubic operation, and in the perineal operation it is also traversed between the bladder and rectum. Fortunately no harm arises in the great majority of cases, because of the free drainage which is provided in both operations; opportunity for extravasation into the loose tissues is therefore rarely afforded.

In some cases, however, the true or the ill-developed pathological capsule may be so adherent that real enucleation is an impossibility (*vide* Fig. 253).

An inexperienced surgeon performing the supra-pubic operation may fail to find the proper layer for separation, and then he will either effect an incomplete removal of the prostate, or, on the other hand, he may tear or cut through the fibrous sheath and invade the delicate and loose pelvic cellular tissues. The one mistake is liable to be followed by a stricture or recurrence of the enlargement, while the other may

result in severe hæmorrhage from the prostatic plexus or in disastrous pelvic cellulitis. For these reasons the finger is infinitely better than any instrument for enucleating the prostate from above the pubes and within the bladder. It is of supreme importance to commence the enucleation between the proper layers, and in order to do this the mucous membrane of the bladder must be incised over the prominence of the vesical projection, where the prostate is only covered by mucous membrane. The incision should also be within the widened circle of the sphincter, which surrounds the base of the part which projects into the bladder. Generally the incision can be most advantageously made a little behind the funnel-shaped urethral orifice, and upon the so-called median lobe. When this does not exist, the opening may be made over a lateral projection.

Indications for Operation.—The ideal conditions for operation are—

(1) A prostate moderately but not hugely enlarged—one that has loosened within its coverings by the separating action of the enlargement. A greatly enlarged gland is difficult to remove even supra-pubically because of impaction in the pelvis, and the difficulties of the perineal operation under these circumstances are very much greater.

(2) Above all, the absence of renal sepsis and degeneration from backward pressure and other causes. The operation should be undertaken, if possible, before the output of urea has been seriously diminished by long-continued obstruction and secondary fibroid changes in the kidneys, and especially before the development of cystitis, pyelitis, or ascending nephritis.

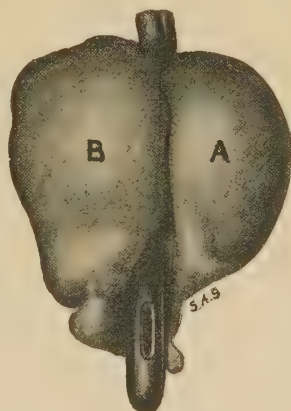
(3) The absence of vesical stone and sacculation of the bladder from old-standing obstruction.

(4) The absence of much impairment of the general health and of serious disease of the vital organs.

To get the great advantages of operating under these favourable conditions as far as possible it is best to operate before the obstruction is sufficient to need the habitual or even the occasional use of a catheter for its relief, for, except under quite exceptional circumstances, catheter life is bound to lead sooner or later to cystitis and ascending septic changes, which may either terminate the life of the patient from septicæmia within a few days, or may subside for a time only to be repeated again and again, until the chances of surviving an operation, and of a complete local relief and recovery of the general health, are very materially diminished. It is best of all to operate before the residual urine becomes more than about 2 or 3 oz., even when a catheter has never been used before, unless the residue can be drawn off once daily under circumstances which are unusually favourable for preventing infection of the bladder.

Residual urine is very apt to become foul either from infection by

FIG. 254.



Prostate weighing only three-quarters of an ounce (Freyer), outgrowth into bladder. The patient was entirely dependent upon a catheter.

a catheter or from the rectum. The degree of disability in micturition and the amount of residual urine are far more valuable than the apparent size of the prostate as ascertained by rectal and bimanual examination, for it is a matter of common knowledge that the size of the prostate does not bear any constant relation to the disability. A cystoscopic examination helps very considerably in suitable cases, for a vesical projection or a collar may be seen, and the condition of the bladder ascertained (*vide* Fig. 254). In some cases a pouch or a calculus may be seen, as in one of my cases; in others carcinoma of the bladder is a surprise; but it must not be forgotten that neither rectal nor vesical examination, even through a supra-pubic wound, may discover any enlargement which appears to be sufficient to produce an obstruction that is known to exist. In such a case the prostate is unusually firm and only slightly enlarged as felt per rectum, but the urethra is nevertheless obstructed. The following case may serve to illustrate this point, and it also presents several other interesting and unusual features:—

The patient, who was only 48 years of age, was brought to see one of us (R. P. R.) by Dr. Evan Evans, now of Lampeter, who had seen the patient in consultation with his usual medical attendants at Aberayron. The patient gave a history of difficulty in micturition for about seven years off and on, and for the last two years he had been practically dependent upon a catheter, which he had learnt to pass after several attacks of acute retention. He had suffered much from acute and chronic cystitis, and had sometimes to pass the catheter every hour or two. Irrigation with a solution of silver nitrate had given some relief. The catheter entered without much difficulty, although the patient hated passing it on account of the pain, which he said was very severe. On two occasions he had journeyed to London to consult well-known surgeons, and one of these, with a great experience of urinary diseases, suggested a median perineal cystotomy after giving the doctor a diagnosis of congenital stricture of the neck of the bladder.

When I saw the patient in October, 1905, the bladder had never been examined by means of the sound or cystoscope. The prostate was firmer than usual even, and slightly enlarged. The urine was foul, the total urea was diminished almost to half the normal, and the general health was considerably affected, although there was no sign of cardiac or pulmonary disease beyond a little chronic bronchitis.

The bladder was washed out, and the cystoscope was easily introduced; the beak immediately struck a stone of large size: therefore it was decided not to waste time upon a further examination. Supra-pubic cystotomy was performed, and the stone was removed.

On sweeping the finger round the bladder two pouches were discovered, a small one to the right and posteriorly; the other, a much larger one, with a small orifice on the left wall of the bladder, extended towards the left iliac fossa, and contained a large stone, which was removed with great difficulty, for the small orifice contracted upon the finger and instruments. The stone, which was a phosphatic one, was crushed and ultimately removed. There was very little alteration of the urethral orifice of the bladder. The prostate was not removed because the operation had already lasted quite long enough. The patient was exhausted from chronic cystitis and pyelitis, and the excretion of urea was diminished. It was felt that the large stone, placed at the bladder base, might have been at least partly responsible for the obstruction. Four months later the patient returned greatly improved in general health, and with his urine in a fairly healthy condition, and containing far more, but not the normal amount of, urea; but he had not been able to pass any water in the natural way. The prostate was still firm, even upon the surface, and a little larger than normal.

The urethroscope was passed into the prostatic urethra with the hope of discovering the cause of the obstruction, and the lateral walls were seen to bulge inwards, so that the

urethra consisted of a mere antero-posterior slit. Small whitish elevations, probably adenomatous, were seen upon the projecting surfaces.

A few days later the prostate was removed supra-pubically, with unusual difficulty, for it was a small fibroid body which was practically incapable of enucleation, the true capsule being adherent to the sheath, probably as a result of repeated attacks of prostatitis and cystitis.

Although the patient lost a great deal of blood, and afterwards vomited persistently for four days, he made a good recovery, and he is now, a year after the operation, quite well and able to carry on his business. He can empty the bladder completely and easily, and he does not get up to pass his water during the night. The sexual power has returned, but seminal emissions do not occur. The vomiting was considered to be uræmic in origin.

It is curious that the patient's father, grandfather, and several uncles, have suffered from enlargement of the prostate, some of them at unusually early ages.

Care must be taken not to mistake the hard, fixed and nodular enlargement of the carcinomatous prostate for the adenomatous so-called senile hypertrophy.

When the catheter can be used under the most favourable circumstances complications may be long delayed, but, sooner or later, acute retention will supervene in the large majority of cases, and this may be accompanied by intra-vesical hæmorrhage, and followed by cystitis either from infection arising from the careless use of instruments, or from the rectum. Vesical calculi may slowly develop, and the kidneys may become affected.

Complete retention, incapable of relief by any catheters, even when used by an experienced surgeon, may develop at any time.

It is not wise to remove the prostate when an operation becomes necessary for complete retention. It is far better to be content with supra-pubic drainage until the acute symptoms have subsided, for the congestion of the prostatic plexus is extreme, and the urine too often foul under these circumstances. After a variable interval the prostate may be removed under more favourable circumstances, if the patient prefers this to either permanent drainage, or the almost certain return of his acute retention at no distant date.

Unfortunately patients frequently do not seek treatment, or do not consent to any operation until some complication or other has made life a burden; and they may not consent to an operation until grave changes have taken place in the kidneys. It then becomes a difficult question to decide for or against a radical operation. Similar difficulties arise in advising patients who are very decrepit, or suffering from cardiac, pulmonary, or other diseases. Under these circumstances, the danger of the operation is considerably increased, and the advantages derived from it may be comparatively short-lived, on account of the general condition of the patient, and the shortness of the natural expectation of life.

In the absence of evidence of grave interference with the renal function, however, supra-pubic prostatectomy may be undertaken by a skilful surgeon, with a sufficient experience of this operation, if the general health is good enough to justify the administration of the general anæsthetic that is generally required. Local or spinal anæsthesia may be sufficient in some cases.

In many cases the question of operation will depend upon (a) the possibility, or otherwise, of leading a catheter-life under circumstances which are favourable for avoiding septic infection; (b) the degree of

discomfort and disability involved by catheter-life in the given case; (c) the risk of the operation for the patient under consideration, is it likely to be so great, on account of renal changes, general disease, or extreme age, as to make the operation inadvisable, although it would, if successful, give great relief as long as life lasts?

In conclusion, it may be briefly stated that the cases in which, in my opinion, the operation is most called for, fall into two groups. (A) *The more urgent.* (1) Where previous appropriate treatment, carefully carried out, has failed; (2) where there have been one or more attacks of retention; or (3) where hæmorrhage has taken place. In either case the peril of cystitis, too often fatal here, is enormously increased. (4) Where there is inability to micturate, but the patient is dependent upon the use of a catheter, and especially when he cannot pass this himself, or get someone to do it for him, with all the care and cleanliness that is necessary to prevent infection. This will depend largely upon the education and the means at the disposal of the patient; in a hospital patient it is far safer to operate than to allow the patient to attempt to pass a catheter himself. (5) Where micturition becomes increasingly painful and frequent; (6) where the passage of the catheter is increasingly difficult with the risks of hæmorrhage, formation of false passages, &c.; (7) where the prostate is soft and elastic, not densely hard and fibrous; the immediate risk of operating for the latter is greater, and the chance of a perfect result is less, but the prognosis is better when the perinæal operation is chosen. Of course, the greater the power of voluntary micturition which remains, the more natural the urine as to urea, sp. gr., albumen, and sugar, the greater the rallying power of the patient, and the clearer the mind the better the prognosis. (B) *Less urgent cases.* Here the operation is prospective and preventive. The patient is younger, the power of voluntary micturition is still good, there is no cystitis, but palliative treatment fails to relieve the frequent disturbances at night, and hæmaturia has begun to occur at intervals. Here the surgeon is abundantly justified in advising the operation as a preventive of worse things which are certain to come. The operation will not be often accepted here, but it is in such cases that it will give the best results.

THE CHOICE OF OPERATION.

The choice lies chiefly between supra-pubic and perinæal total enucleation. Partial supra-pubic prostatectomy and all other partial removals are unsatisfactory either immediately or remotely or both.

Combined perinæal and supra-pubic operations are rarely necessary, although they may afford a better control of and access to the gland in fat subjects, and in some other difficult cases. The mortality is, however, considerably higher than when either the supra-pubic or the perinæal route is adopted alone.

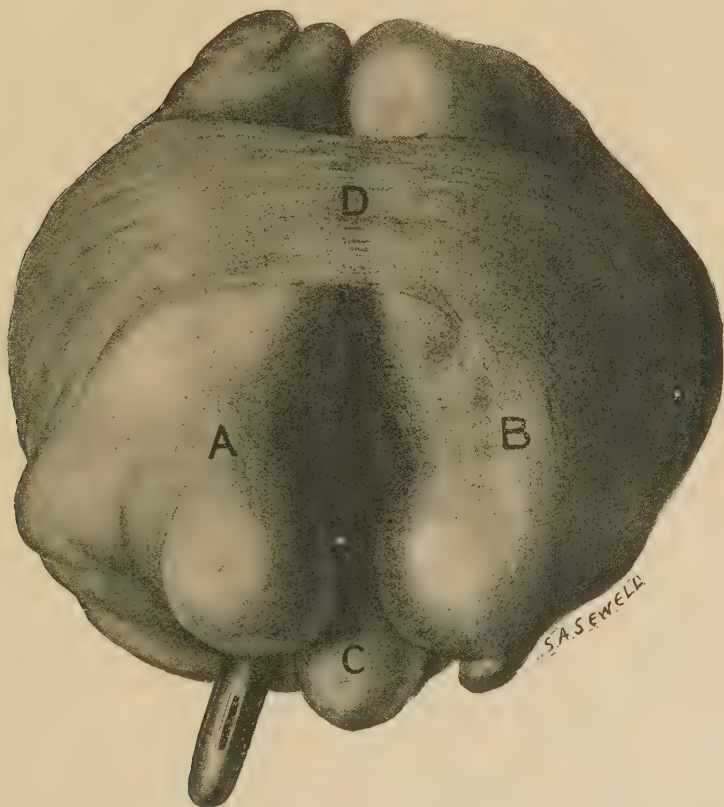
(1) *Duration of the Operation.*—The supra-pubic operation can be more quickly performed than any other except in the rare cases of small and adherent prostates.

(2) *Ease.*—The supra-pubic is easier than the perinæal operation in the great majority of cases, and this is especially true for very large prostates (Fig. 255), but it is not true for small glands, which do not

enucleate but have to be cut away, for it is a distinct advantage for the surgeon to see what he is doing in these cases (Fig. 253).

(3) *Completeness of the removal and certainty of complete relief.*—The supra-pubic route allows the removal of the gland *en masse* and surrounded by its true capsule. This is a distinct advantage, for the surgeon can be more certain of completely removing the prostate, whereas in the perinæal operation the enucleation is always more or

FIG. 255.



Prostate weighing 10½ ounces, actual size. (Freyer.) A. Left lobe. B. Right lobe. C. Polypoid outgrowth from right lobe. D. Thin band of pathological capsule.

less piecemeal. Vesical projections are apt to be overlooked, and hence the relief is less often complete after the perinæal than after the supra-pubic operation.

(4) *Exploration of the Bladder.*—No one denies that a supra-pubic cystotomy allows the most complete examination of the interior of the bladder, and the best guarantee that calculi or sacculi or both may not be overlooked.

(5) *Incontinence of Urine.*—This not uncommonly follows the perinæal operation from interference with the compressor urethræ or

its nerves or both. Dr. Ruggles (*Ann. of Surg.*, 1905, vol. xli. p. 559) states that incontinence occurred in five out of 39 cases at Rochester; in three of these this serious affliction was permanent, and in one other it lasted for two years. Dr. Watson states that incontinence follows 3·5 per cent. of the perineal operations. On the other hand, this troublesome sequela rarely or never follows the supra-pubic operation, for the operator working within the fibrous sheath of pelvic fascia need never trespass on the region of the sphincters and their nerves.

(6) *Rectal Injury*.—The rectum has been occasionally injured during the perineal operation, and a troublesome recto-urethral fistula has not uncommonly resulted. Dr. Watson states that it has occurred in 2·7 per cent. of the cases. There is practically no danger of this accident with the supra-pubic method, for the finger of the surgeon is kept well away from the rectum by the posterior wall of the strong fibrous sheath of the prostate. With dense and adherent prostates it is, however, possible to tear through this sheath and injure the rectum, but this must be a very rare accident, whereas Belfield states that perineal or rectal fistula occurred in 8 per cent. of 2,000 perineal prostatectomies (*Ann. of Surg.*, January, 1907, p. 101).

(7) *Drainage*.—This is a little freer with the perineal operation if the removal is complete, and certainly as regards the wound it is better; it is a disadvantage, however, to have to pass a tube on to the bladder base, where it induces more pain, than the supra-pubic tube properly inserted. Moreover, the patient cannot sit up so comfortably, and the sitting-up posture is of value in avoiding pulmonary complications.

(8) *The Duration of Anæsthesia*.—A shorter anæsthesia is required for the supra-pubic operation, and therefore the complications arising from the anæsthetic are less likely to follow it. Wiener (*Ann. of Surg.*, vol. xli. p. 541) records eleven supra-pubic prostatectomies performed under nitrous oxide anæsthesia, and all the patients recovered.

The lithotomy position is not a good one for a prolonged anæsthetic, especially in elderly men with rigid chests. It is, however, possible to perform both the perineal and the supra-pubic operations under spinal anæsthesia (Young, *Journ. Amer. Med. Assoc.*, Feb. 4, 1905). As a rule, however, a general anæsthetic is to be preferred and is to the advantage of both the patient and the surgeon.

(9) *Permanent Urinary Fistula* should be very rare after both the perineal and the supra-pubic operations, and there is little difference in the time taken for the wounds to close if the enucleation has been complete, although the perineal fistula closes a little earlier as a rule.

(10) *The Loss of Sexual Power and Sterility*.—This is more common after the supra-pubic operation than after a perineal one performed by Young's method. It should be remembered, however, that the impotence is not uncommon before the operation, and that the loss of sexual power is immaterial in the majority of cases, although it may be a serious matter in the few comparatively young men. Further, the sexual power is preserved in some cases after the supra-pubic operation.

(11) *Epididymitis* is more common after the perineal operation.

(12) *The Comparative Mortality*.—It is difficult to arrive at any reliable conclusion upon this subject, for some surgeons select their cases; others, properly regardless of their statistics, do not refuse an operation if there seems to be any chance of affording relief to the patient.

Mr. Freyer records twenty-two deaths in 312 supra-pubic operations, a mortality of about 7 per cent. Young lost four of his 74 cases of perinæal prostatectomy, a mortality of 5·4 per cent. It can be safely stated that in skilled hands the mortality of either of these operations should not be more than 10 per cent., and is likely to be somewhere between 5 and 10 per cent.

(13) Pelvic cellulitis is a little more common after the supra-pubic operation, because of the better drainage of the cellular tissues provided by the dependent perinæal incision.

(14) The supra-pubic operation is not suitable for the comparatively rare cases of contracted bladder with thin non-distensible walls. In conclusion it may be stated that the supra-pubic operation is the most suitable for critical cases, demanding a short operation with little shock and little anæsthetic; it is also to be recommended when the prostate is greatly enlarged, and when there are intra-vesical projections. When large stones or sacculi are present or a need for thorough examination of the interior of the bladder exists, the supra-pubic route is the best. The perinæal operation is more suitable for the removal of small hard enlargements, and for comparatively young men, to whom the sexual power is known to be of importance. It is not easy to perform in fat and bulky patients.

The future will almost certainly show the results of the supra-pubic method to be at least a little better than those of the perinæal operation. The one operation should be the complement of the other, and neither of them should be exclusively adopted for all sorts and conditions of a variable disease.

PARTIAL PROSTATECTOMY.

We owe our knowledge of what this operation can do to the late Mr. McGill, of Leeds (*Brit. Med. Journ.*, Oct. 19, 1889).^{*} The following propositions are taken from his paper:—i. Prostatic enlargements which give rise to symptoms are intra-vesical, not rectal. Thus prostates of immense size which project towards the rectum cause no urinary trouble, while severe symptoms may supervene when the prostate on rectal examination is apparently of normal dimensions. ii. There are many varieties of the intra-vesical growth. We find (1) a projecting middle lobe—pedunculated or sessile, (2) a middle lobe with lateral lobes forming three distinct projections, (3) the lateral lobes alone, (4) a pedunculated growth springing from a lateral lobe, and (5) “a uniform circular projection surrounding the internal orifice of the urethra.” This variety, described by Brodie, is not infrequent, it surrounds the urethra like a collar, and projects for a variable distance

^{*} Much information will be found in the following papers: Watson, *Ann. of Surg.*, 1889, pp. 1–27; Belfield, *Amer. Journ. Med. Sci.*, Nov. 1890; Moullin, *Brit. Med. Journ.*, 1892, vol. i. pp. 1185, 1250, 1294; White, *Ann. of Surg.*, 1893, p. 152; Woolsey, *Journ. Cut. and Gen. Urin. Dis.*, July and Aug., 1895; Watson, *Ann. of Surg.*, 1904, vol. xxxix. p. 833; Young, *ibid.*, 1905, vol. xli. p. 549; Pilcher, *ibid.*, p. 565; Wiener, *ibid.*, p. 541; Cunningham, *ibid.*, p. 590; Mansell Moullin, *Enlargement of the Prostate*, 1904; Freyer, 1906; Cuthbert Wallace, *Trans. Path. Soc.*, 1905, vol. lvi. Part I., and *Practitioner*, Sept., 1905.

into the bladder. iii. In many cases self-catheterism is the only treatment required. iv. That when this fails, or is unavailable, more radical measures are necessary. v. That this treatment, to be effectual, should (1) for a time thoroughly drain the bladder; (2) permanently remove the cause of the obstruction. vi. That the supra-pubic route is preferable to the perinæal for prostatectomy. Most surgeons will agree with this; the question is alluded to at p. 666, and again below. This operation was short-lived, as it was laid aside for double castration, which at first seemed to be much less severe, but for a variety of reasons orchidectomy and allied procedures have given way to total perinæal and supra-pubic prostatectomy, which are now safer as well as more successful than either partial prostatectomy or castration. Partial prostatectomy had a mortality of 15 to 20 per cent., and Watson gives that of double castration as about 16 per cent.

Secondary operations have often had to be undertaken after these procedures. For these reasons partial prostatectomy will not be described here. For an account of Fuller's method of partial prostatectomy combined with perinæal drainage, *vide* p. 680.

SUPRA-PUBIC COMPLETE PROSTATECTOMY—TOTAL ENUCLEATION OF THE PROSTATE.

Although the late Mr. McGill,* of Leeds, certainly removed large portions of the prostate bit by bit, and although the removal may have been complete in one or two cases, there is little doubt that the credit of introducing and perfecting the operation of total enucleation of the prostate *en masse* belongs to Mr. Freyer, who first showed that this was a feasible and rational surgical procedure (*Brit. Med. Journ.*, July 20, 1901).

Partial prostatectomy, however extensive, was a very different thing from complete prostatectomy as now performed, and it was not attended with sufficient success to justify its general adoption. It was, in fact, almost completely abandoned for other measures, such as castration and vasectomy, which held their sway for a time, but have been generally discarded now (*vide* p. 682).

For much of the following description of the operation I am indebted to Mr. Freyer's instructive work upon this subject.†

Preparation.—If possible, the patient should be kept at rest for three or four days before the operation, the bowels should be opened daily, and an enema given early on the morning of the operation, so that the rectum may be quite empty. Any bronchitis that may be present should be attended to, or in some cases which do not call urgently for relief, the operation should be delayed until the pulmonary symptoms have abated.

In cases of cystitis, the bladder should, if practicable, be washed out once every day with a solution of silver nitrate $\frac{1}{5000}$, followed by boracic lotion toward the end of the irrigation. If cystitis be absent, lavage is neither necessary nor wise.

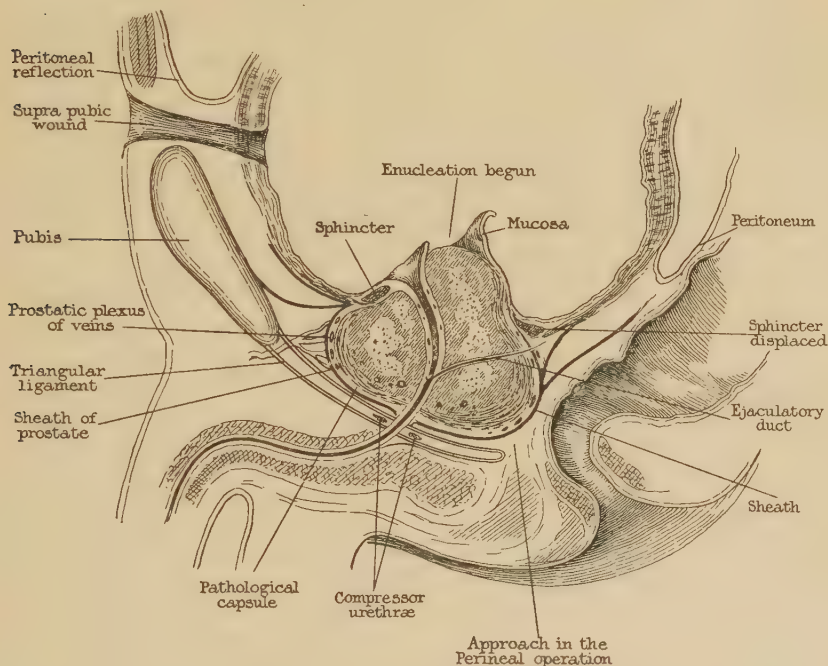
* *Brit. Med. Journ.*, Oct. 19, 1889. Dr. Fuller (*loc. infra cit.*) also removed most of the prostate supra-pubically (*vide* p. 680).

† *Enlargement of the Prostate*, 3rd ed., 1906.

For cystitis, certain drugs may be given with the object of lessening the alkalinity of the urine, and of making the interior of the bladder less septic.

Urotropine gr. xv. or helmitol gr. x. may be given in water twice a day, or boracic acid gr. xx. dissolved in warm water with the aid of borate of soda or ammon. benzoat. gr. xv. with tincture of hyoscyamus may be administered. The pubis is shaved, and the parts cleansed and compressed overnight.

FIG. 256.



The anatomy of the prostate. Supra-pubic enucleation, and the line of approach in perineal prostatectomy. The direction of most of the fibres of the pathological capsule is transversely circular. The relations of the capsule, sheath, and prostate are shown. The vesical mucosa which covers and is separated from the prostate falls down and forms a funnel which joins the remains of the lower part of the prostatic urethra, after the gland has been enucleated.

The patient is anæsthetised, after all the preparations have been completed.

Operation.—The bladder is thoroughly washed out through a large-sized catheter, and then distended with boracic lotion. The catheter is plugged and left in. A vertical median incision three inches long is made with its lower extremity at the pubis. The rectus sheath is opened, the muscular fibres separated, and any hæmorrhage arrested.

The prevesical fat is displaced upwards, carrying with it the peritonæum out of harm's way, and leaving the bladder exposed.

A bloodless spot is selected and the knife plunged into the bladder; as it is withdrawn the incision is enlarged downwards, so that it is about an inch long. Mr. Freyer enlarges the wound by stretching if

this becomes necessary later on. This has the advantage of avoiding any increase of hæmorrhage.

To avoid separation of the bladder from the pubis, and subsequent contamination of the delicate connective tissue of the Cave of Retzius, some surgeons sew the edges of the vesical wound to the skin.

This also serves to fix the anterior wall of the bladder, which facilitates the enucleation of the prostate to some extent, for the latter is steadied and brought a little forward.

That this procedure is not essential is shown by Mr. Freyer's success without it. The vesical orifice and the whole of the interior of the bladder are now carefully and rapidly examined, so that no calculus or stone-bearing diverticulum may be overlooked. In one of my cases, I removed a large oval stone from behind the prostate, and another with much difficulty from a narrow-necked pouch which had terminated from the left lateral wall high up (p. 664).

An incision is now made over the greatest prominence of the prostate, which is usually a little behind the urethral orifice. This is best made with long-shanked scissors curved on the flat and blunt-pointed, the left fore-finger being used as a guide.

Freyer uses a finger-nail for tearing through the mucous membrane, so that he may not go too deeply and thus miss the proper layer for enucleation, for the prostate is covered only by thin mucosa on its vesical surface. However safe this plan may be for Mr. Freyer, it is far more aseptic for the average surgeon to cut his nails very short, so that nothing can collect under their cut edges and there avoid the nail-brush and the punice stone. It is very important to find the proper layer for the separation, and not to trespass upon the fibrous sheath with its venous plexus. But if the first incision is carried too deeply true enucleation becomes impossible, and the difficulties and dangers of the operation are greatly increased, hæmorrhage is more profuse, much valuable time is wasted, and the removal is incomplete.

When the left fore-finger has found the proper layer of easy enucleation, one or two fingers of the other hand, which is covered with a rubber glove, are inserted into the rectum, to act as a useful guide and to push the gland upwards and forwards. The prostate is now fixed between the rectal and vesical fingers, the triangular ligament and the pubis.

An assistant's finger in the rectum is not so valuable, for the operator cannot direct it so well, nor can he get the same control over the prostate. The combined action and sense of touch of the operator's own fingers are far more useful. The glove is removed when the finger is withdrawn from the rectum, and the hand rinsed in lotion. The separation is carried on behind, at the sides and in front of the prostate, the finger being always kept close to the prostate and within the pathological capsule and the fibrous and vascular sheath of pelvic fascia, until the gland is free, except below where the urethra attaches it to the triangular ligament. The tip of the finger is now bent and gently separates the urethra from within the apex of the prostate as far as possible, the catheter serving as a useful guide. The finger behind the urethra hooks the prostate and urethra upwards and forwards, with the result that the latter snaps at or above the insertion of the

ejaculatory ducts; above this point the tube is more closely attached to the prostate, and comes away with it. Mr. Freyer states that the insertions of the ejaculatory ducts are often preserved and remain attached to the lower part of the prostatic urethra, which is firmly fixed to the triangular ligament. At the end of the manœuvre which has been just described the prostate shoots up into the bladder, whence it is withdrawn by strong and suitable forceps, which compress the gland sufficiently to allow its removal through the comparatively small vesical incision.

Before the finger is removed from the rectum the fibrous wall of the cavity which contained prostate are compressed, so as to diminish the size of the space that is left to heal. The loose lower parts of the vesical wall soon fall down into and line this cavity, and unite with the upper end of the urethra.

After the removal of the prostate, the bladder is thoroughly washed out through the catheter, which is still in. Hot boracic lotion (110 degrees Fahr.) is used for this purpose. As soon as the clots have come away the irrigation is left off. In a few cases bits of prostatic tissue and clots have been left behind and have formed the nuclei of stones. A large rubber tube ($\frac{3}{4}$ inch diameter) is inserted so that it projects for only about one inch into the cavity of the bladder, so as not to irritate the bladder base. The vesical part of the tube is fenestrated, and the other end is sewn to the skin. A piece of gauze is passed by the side of the tube into the Cave of Retzius at the lower angle of the wound for draining the prevesical space in case any leakage should occur in the first 24 hours. If an unusually large vesical wound has had to be made it should be partly closed with a continuous inverting catgut suture, so that the drainage tube fits snugly in the remainder, which is at the lower end near the pubis. The upper part of the parietal wound is closed by interrupted salmon-gut sutures, which pass deeply and approximate the muscles and fasciæ, so that a ventral hernia may be prevented. No buried sutures are used. Sufficient lotion may be injected through the catheter to prove the efficiency of the supra-pubic drainage, and the catheter is then withdrawn. The wound is covered with Cyanide gauze, and a large quantity of cotton wool, which ensheaths the back and sides as well as the front of the pelvis. A many-tailed bandage is used to keep the dressings in position.

The after-treatment.—This is almost as important as the operation, and much depends upon the care and thought with which it is carried out. Free drainage is essential for success, and any failure of it may induce pain and hæmorrhage from distension, and cystitis, cellulitis, or renal complications may develop.

Irrigation should be carried out once daily through the supra-pubic drainage tube, a glass tube attached to an irrigating can being passed through the rubber tube and well into the bladder; the fluid returns freely through the drainage tube.

Very little hydrostatic pressure is either advisable or comfortable at first, the can or funnel being only about six inches above the level of the abdomen; distension is painful and apt to cause hæmorrhage.

Warm boracic lotion is the best for general use, but when cystitis develops or, rather, pre-exists, $\frac{1}{2000}$ of nitrate of silver solution should be used, and followed by the boracic lotion.

The patient should be kept still during the first 24 hours, but as soon as the shock is over he must be propped well up, and made to lie alternately upon his sides and back, so that pulmonary complications may be avoided. The outer dressings should be changed whenever they get wet, so that the skin may not get sore, or the patient uncomfortable. Shock should be treated as already described, p. 305. Hæmorrhage by subcutaneous injection of aseptic ergot and free drainage of the bladder. Pain should be relieved by morphia, unless the kidneys are very gravely affected. Threatening uræmia should be met by ingestion of abundance of fluid, and by infusion of saline solution if fluid is not retained by mouth or rectum. The bowels are kept open daily after the second day. The drainage tube can be safely removed on the fourth day, there being no fear of extravasation into the pelvic cellular tissues. Irrigation is then carried out by introducing the glass tube through the sinus as long as this is practicable, and then by hydrostatic pressure through a catheter inserted through the urethra; this will not become necessary until about the ninth day. It is not necessary to tie the catheter in, with the idea of preventing a stricture. Its introduction and its continued presence only serve to irritate the urethra and the healing part without any compensating advantage. The urine should begin to come away through the urethra after about 10 to 15 days, and should be voided entirely along the natural passage after about three weeks or a month. After the supra-pubic drainage tube has been left out Colt's improved apparatus may be found very useful to keep the patient dry (*vide* Fig. 240, p. 602). Mr. Freyer thus speaks of the results of his 312 supra-pubic prostatectomies. "The vast majority of the patients had been entirely dependent on the catheter for periods varying up to 24 years. Nearly all of them were in broken health, and many were apparently moribund, when the operation was undertaken.

The great majority of them were, indeed, reduced to such a wretched condition that existence was simply unendurable. Few of them were free from one or more grave complications, such as cystitis, stone in the bladder, pyelitis, kidney disease, diabetes, heart disease, thoracic aneurism, chronic bronchitis, paralysis, single, double, or even treble hernia, hæmorrhoids, and in a few instances cancer of some other organ than the prostate. Such then were the unpromising conditions under which the operation was undertaken.

In connection with these 312 operations, there were 22 deaths, the remaining 290 cases being successful, and when I speak of success I mean complete success, the patients regaining the power of retaining and passing urine naturally without the aid of a catheter, as well as they ever did. There are no half measures about this operation. The patient can be assured beforehand that if he is prepared to accept the comparatively small risk attaching thereto, he can with absolute certainty look forward to a complete cure. In no instance has the patient failed to regain the power of voluntary micturition without the aid of a catheter. There has been no instances of relapse of the symptoms; on the contrary, lapse of time only seems to consolidate the cure. In no case has there been contraction at the seat of operation leading to organic stricture; nor has there been any instance of a permanent fistula remaining. In very few instances have distinct

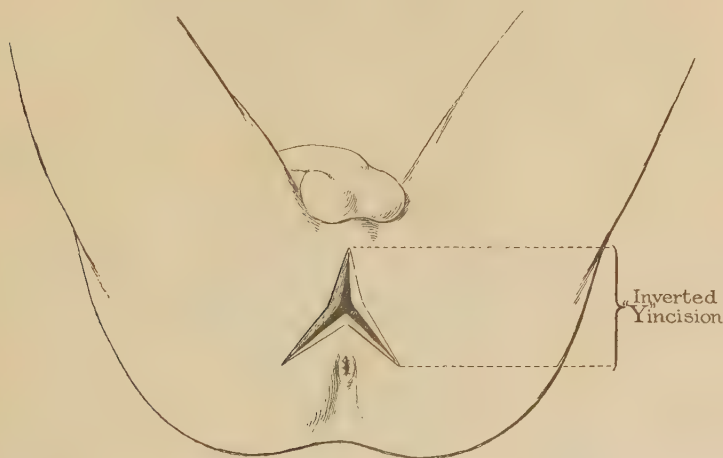
symptoms of septicæmia supervened. Considering that in nearly the whole of the cases the urine was septic, and in many putrid before the operation, this comparative absence of septicæmia is remarkable. To what are we to attribute this immunity. No matter how carefully the bladder is irrigated, it is quite impossible to keep the wound aseptic. It must be remembered that a very large proportion of aged men succumb to septicæmia on entering on what is commonly termed catheter life. Probably those that survive become more or less immune by gradual absorption of toxins from the septic urine, that prevails sooner or later in all cases of habitual employment of the catheter."

The average age of the patients was 68 years, and the average weight of the prostates removed was $2\frac{3}{4}$ ounces; the largest was $14\frac{1}{4}$ ounces.

PERINÆAL PROSTATECTOMY.

The bladder having been washed out and the patient placed in the extreme lithotomy position, so that perinæum almost faces upwards,

FIG. 257.



Perinæal prostatectomy. Inverted Y-shaped incision. (After Watson, *Ann. of Surg.*) An inverted V or a semilunar incision is generally sufficient.

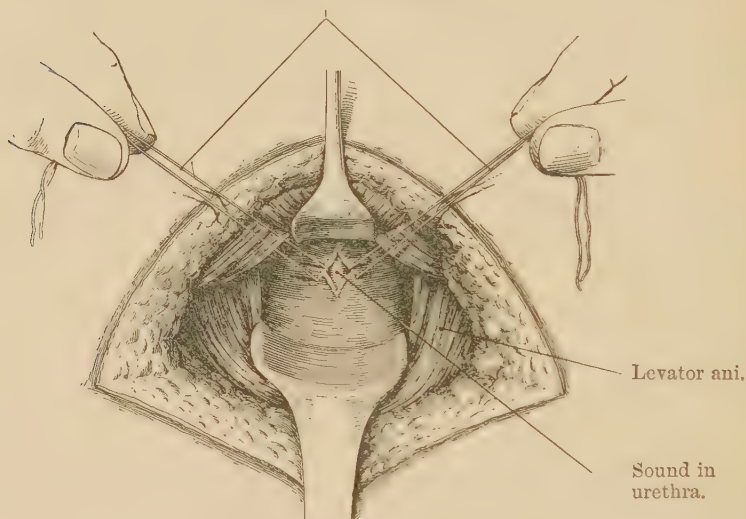
an incision is made as shown in Fig. 257. The one shaped like an inverted V is sufficient in most cases, and the angle may be avoided, and a semilunar wound made after the ancient plan adopted by Celsus for lithotomy. The central tendinous point of meeting of the perinæal muscles is sought, and a transverse incision made through it separating the accelerator urinæ, and transverse perinæal muscles from the sphincter ani insertion. This step is of great importance, and must be carefully observed, otherwise the rectum may be injured. The rectum is now carefully displaced backwards by blunt dissection, which is carried deep enough to expose freely the posterior surface of the fibrous sheath of the prostate. The wound is well opened with retractors. A grooved staff is passed into the urethra, which is opened exactly in the middle line upon the staff well above the triangular ligament and through the apex of the

prostate to avoid any possible injury of the compressor urethræ. The edges of the urethral incision are picked up and retracted with tissue forceps or sutures (*vide* Fig. 258).

Young's tractor (or that of de Pezzer) is then passed through this opening well into the bladder; its blades are opened out. Traction is

FIG. 258.

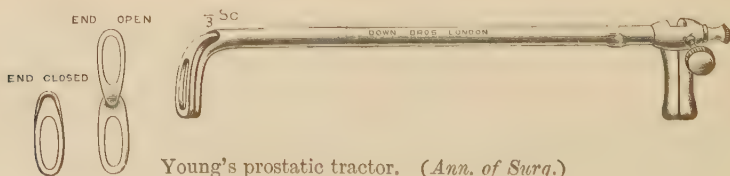
Sutures holding urethra open.



Perineal prostatectomy. Opening the urethra at the apex of the prostate upon a grooved sound. The levatores ani are drawn backwards with the rectum by smooth retractors, and the transverse perineal muscles are drawn forwards with the accelerator urinæ, and the bulb of the corpus cavernosum. The posterior surface of the prostatic "sheath" is shown. (After Young, *Ann. of Surg.*)

then made with the blades of the instrument directed laterally above the lateral lobes of the prostate (*vide* Fig. 259). These and similar tractors are of great value in bringing the prostate downwards and backwards well into view. The finger, passed through the urethra,

FIG. 259.



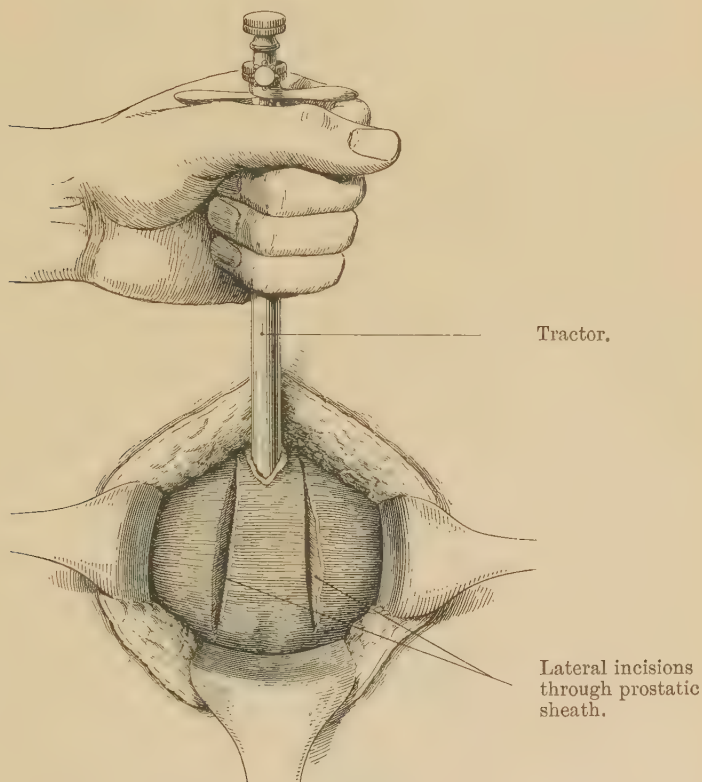
Young's prostatic tractor. (*Ann. of Surg.*)

although sensitive, is not nearly so serviceable and is in the way, as well as needed for other purposes. Supra-pubic pressure is rarely efficient, and traction through the rectum is dangerous. Care must be taken, especially towards the end of the enucleation, not to exercise too much force with tractors, lest the blades tear through the thin vesical mucosa, and bring away the urethra and vesical outlet

(Watson, *loc. infra cit.*). When the posterior surface of the prostatic sheath is displayed two lateral incisions are made through it, so as to expose the true capsule within (Fig. 260).

Young (*Journ. Amer. Med. Assoc.*, Oct. 24, 1903) uses these lateral incisions in order to avoid injuring the ejaculatory ducts which run between the two incisions (Nicoll occasionally used similar incisions: *Lancet*, April 14, 1894). The lateral lobes are then separately enucleated by blunt dissection with the finger, if possible, care being taken to

FIG. 260.

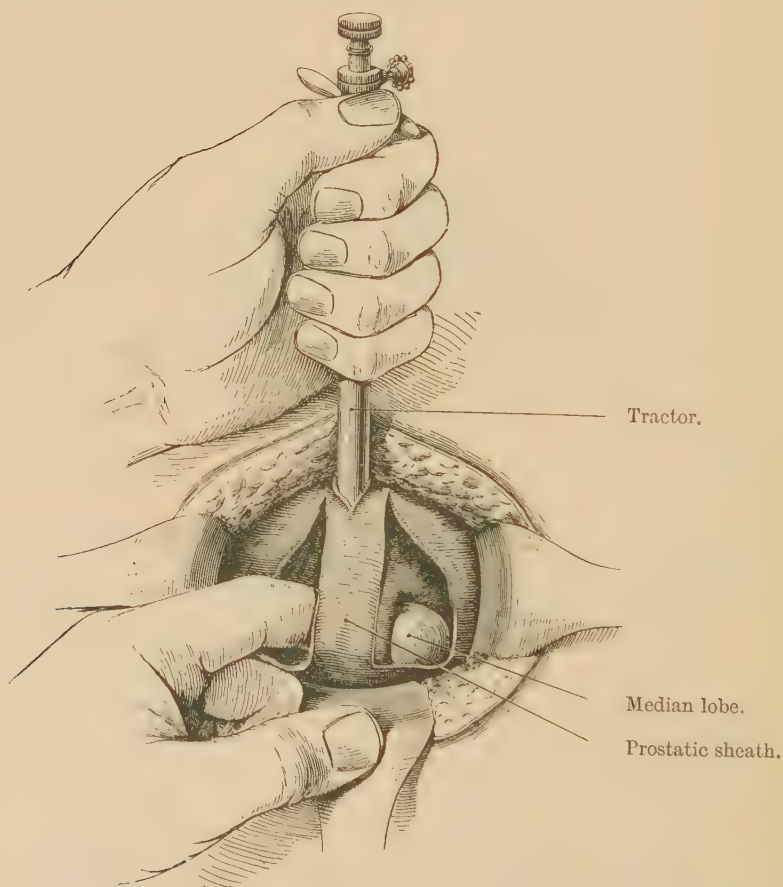


Perineal prostatectomy. Tractor introduced, blades separated, traction made exposing posterior surface of the prostate. Incisions in the fibrous sheath on each side of ejaculatory ducts, exposing the true capsule of the prostate. (After Young, *Ann. of Surg.*)

preserve the urethra, and the mucous membrane of the bladder just below the blades of the tractor. When freely separated each lobe is withdrawn, if necessary, with the aid of forceps. The position of the tractor is then changed, so that one of its blades engages and brings down the median lobe into one of the lateral incisions in the fibrous sheath. If this is not found to be practicable the finger may be used instead of the tractor. Dr. Young states that "in certain cases in which a fibrous median bar or lobe is impossible to remove by the technique described above (in which every effort has been directed to

leave the ejaculatory bridge undisturbed), it may be necessary to deliberately cut through the capsule covering the ejaculatory ducts, and thus expose and enucleate or excise the median prostatic enlargement." If a stone is present in the bladder, even a large one may be removed by "dividing the lateral wall of the urethra and dilating the vesical neck," and mere dilatation gives sufficient room in some cases. The bladder is washed out and a large drainage tube inserted, so that one end is just

FIG. 261.



Perineal prostatectomy. Showing the technique of delivery of middle lobe into cavity of left lateral lobe. (After Young, *Ann. of Surg.*)

within the bladder and the other is stitched to the skin. Dr. Young drains the bladder and carries out continuous irrigation through two catheters tied together, and introduced through the perineal incision. Continuous irrigation is not necessary, but it is sufficient to irrigate once daily. The wound is lightly packed with gauze. The anterior wall of the rectum is examined and protected by suturing the separated edges of the levatores ani in front of it with catgut. Care must be taken not to pack any gauze against the rectal wall lest sloughing occur.

The rubber tube may be left out after five days, and a sound should then be passed through the meatus into the bladder to ensure the patency of the urethra just in front of the perinæal wound (Pilcher, *loc. infra cit.*).

Dr. Young maintains that it is quite possible to remove all the prostate in segments without damaging the ejaculatory ducts, and many of his patients have preserved or regained their sexual power (*Ann. of Surg.*, vol. xli. p. 556). This, although immaterial in most cases, may be of great importance in some, especially in comparatively young men of between 40 and 60. Epididymitis is said to be far less common when the ejaculatory ducts are not divided; when their open ends are left in the deep wound, septic inflammation may travel along them to the epididymus.

Median perinæal enucleation through the urethra.—The urethra is opened, as in median perinæal cystotomy, and the prostate enucleated by means of the finger introduced into the prostatic urethra, the lateral walls of the urethra being torn through. The chief objections to this method are that the gland cannot be enucleated as a whole, and it may therefore be incomplete, a vesical projection being very apt to be missed in spite of careful supra-pubic pressure. The room afforded is so small, and the depth at which the work must be done, make it difficult, and even impossible, with large hypertrophies. A perinæal fistula or incontinence may persist. Goodfellow records 78 operations by this method with two deaths, and Murphy 51 with one death: Parker-Sym's 33 with two deaths (Pilcher, *Ann. of Surg.*, 1905, vol. xlix. p. 566).

Dr. Chetwood (*Ann. of Surg.*, 1906, vol. xlv. p. 563) strongly advocates perinæal prostatectomy in two stages, not only when acute retention exists, but also in grave cases of cystitis, renal changes, and general debility, especially in advanced old age. He first performs a median perinæal cystotomy, and about a fortnight later, and under more favourable circumstances, he removes the prostate through the median perinæal incision and prostatic urethra.

COMBINED PERINÆAL AND SUPRA-PUBIC OPERATIONS.

(a) **Nicoll's Operation** (*Lancet*, April 14, 1894).—In this method a supra-pubic cystotomy is performed, the edges of the vesical wound being sewn to the skin, and the bladder examined. A sound or bougie is passed into the urethra, and the left forefinger into the rectum, and a median perinæal incision made to expose the prostate, the rectum being carefully separated from it. In some cases the posterior end of the incision may have to be prolonged towards the tuber ischii on one or both sides to afford more room. A vertical incision is made into the lower part of the prostatic sheath in the middle line, or two lateral incisions in some cases.

The prostate is then enucleated by blunt dissection, the assistant meanwhile affording great help by pressing the prostate down with his finger within the bladder. The urethra is not opened, nor is the vesical cavity invaded from below. A catheter is passed through the meatus into the bladder; the perinæal wound is packed with gauze. The stitches holding the bladder to the skin are then cut, so that the

wound may quickly close. Irrigation is carried out daily through the supra-pubic wound and the catheter.

It is claimed that this method is accompanied with less hæmorrhage than the supra-pubic operation, and that the operator can see what he is doing and remove as much as he likes, also that the patient can sit up, because a perinæal drainage tube is not required. A perinæal fistula can be avoided.

(b) **Fuller's Operation.**—This consists of a supra-pubic enucleation of "hypertrophies" but not a total extirpation; the supra-pubic vesical wound is sutured, and the bladder drained through a median perinæal incision. The bladder having been opened the extent of the prostatic enlargement and the site of this urethral opening determined, the subsequent steps are carried out as described by Dr. Fuller (*Journ. Art. and Gen. Urin. Dis.*, June, 1895, p. 232).

"A pair of rough, serrated-edged scissors with a long handle grasped in the right hand are slipped along the left forefinger into the urethral opening, and are made to cut through the bladder wall in that region. The cut extends from the lower margin of the internal vesical opening of the urethra backward for an inch or an inch and a half. The blades of the scissors being rough and serrated, make an incision which bleeds but little. Then one of the forefingers, whichever the operator may find the more convenient, is slipped through the vesical hole made by the serrated scissors, while at the same time the fist of the other hand makes firm counter-pressure against the perinæum. By means of this counter-pressure the prostatic growth is brought well within reach of the forefinger of the other hand, which is employed all the time in enucleating the obstruction *en masse*, or piece by piece, as the case may be. This enucleation should not be desisted in until all the lateral and median hypertrophies, as well as all hypertrophies along the line of the prostatic urethra, have been removed." Dr. Fuller states that owing to the small amount of bleeding he has always found it feasible to sew up the supra-pubic incision as described below, and that he has never had trouble with secondary hæmorrhage. A perinæal section is next made and a large-sized rubber tube passed through the perinæal incision, and that through which the prostate was enucleated, into the bladder. After this hot-water irrigation is employed for some time to stop oozing. Next, the supra-pubic wound is closed by a deep layer of catgut sutures which include the bladder wall, and by a more superficial layer of silk-worm gut. The middle of the incision is not closed, but a deep provisional salmon-gut suture is inserted here, taking up the walls of the bladder and the abdomen. A drainage-tube is inserted, and when this is removed in four or five days the provisional suture is tightened up. Six cases of prostatectomy, five of these operated on by this supra-pubic method, are given by Dr. Fuller; all were successful.

Bottini's Operation.—The obstruction at neck of the bladder is burnt through by means of a specially designed galvano cautery which is introduced through the urethra. This method has never become popular in England, but it has found more favour in America and upon the continent owing to the advocacy of Gouley and Freudenburg. Its popularity is again on the wane, for it can rarely be any more than a palliative procedure, which is not free of danger.

The following brief description is taken from Mr. Mansell Moullin's *Enlargement of the Prostate*, 1904, p. 172 :—

"Bottini's instrument as modified by Freudenburg resembles a lithotrite in shape, with a male blade made of platinum-iridium, flattened from side to side until it resembles a knife edge, and fitting into a deep recess in the female end. The handle of the instrument is hollow and arranged so that a current of cold water can be kept circulating through it while the male blade is being raised to a white heat.

"No anæsthetic is required, if, that is to say, the urethra is fairly tolerant of instruments. The bladder may be distended with water, but this is not absolutely necessary.

"Of late I have made use of air instead, and it seems to me to answer the purpose better of holding the rest of the wall of the bladder out of the way of the cautery. When the point is in the bladder, it is turned downwards, as in searching for a stone, and gently drawn outwards until it is felt that the beak is in contact with the obstruction.

"If there is any doubt, the exact position of the instrument should be ascertained with the finger in the rectum. The current is then turned on, and the curve pressed against the hypertrophied tissue, a stream of water being made to circulate through the instrument so as to prevent the shaft becoming too hot. By gently elevating the handle the platinum can be made to burn its way slowly through, a hissing sound being distinctly heard. Then the end of the instrument is pushed into the bladder and allowed to cool down. If the scab sticks to it, it must be burnt off. I usually make three linear incisions in this way through the congested mucous membrane at the neck of the bladder, one in the middle, and one on each side. The current required to work effectually must be of considerable strength, twenty or thirty amperes. . . .

"Freudenburg collected the records of 683 patients operated upon by this method, and estimates the mortality at something over 5 per cent., or if deaths not directly attributable to the operation are omitted at a little more than 4 per cent. In only 6 per cent. of the cases was the operation pronounced a failure, while in a third of the remainder it was stated that there was an improvement, and in two-thirds that there was a cure."

The operation can be performed more easily and with more accuracy through a median perinæal incision, as recommended by Watson, and this adds but little to the risk.

The advantages *claimed* for the operation are that it can be performed without an anæsthetic with a low mortality and little shock and without confining the patient to bed for more than a few days. External wounds and fistulæ are avoided. The chief objections to it are the following :—

- (a) The bladder may be perforated.
- (b) Free drainage of the bladder is not provided, and retention may follow it.
- (c) It has a considerable mortality from septic changes chiefly dependent on the poor drainage and secondary sloughing.
- (d) Primary and secondary hæmorrhage has been troublesome.
- (e) Epididymo-orchitis is very apt to follow it.
- (f) Limitations to its value. It is of no use for lateral enlargements ; it should never be used except by a skilled operator, and

then only after cystoscopy has enabled the surgeon to learn the exact conditions present and after efficient distension of the bladder, so that its wall may not be perforated. In some cases of associated stricture or of impassable obstruction of the prostatic urethra this method cannot be adopted, and in some cases it may be impossible to apply the blade to the obstructing parts of the prostate, this may occur in cases where there is a very large high-reaching third lobe (Watson).

(g) As the surgeon is neither able to see nor feel, it is difficult to tell when enough has been done.

(h) A fistula into the rectum or pelvic suppuration may occur.

(i) The immediate results are not often cures, but merely palliative, and the operation is of necessity incomplete, so that the lateral lobes may go on enlarging and lead to a recurrence of symptoms some years after an apparently successful operation. Prostatectomy under these circumstances is very difficult owing to scarring and adhesions (Freyer, *loc. supra cit.*). For these reasons, the operation has a very limited use, but it may be acceptable to some patients in preference to more radical measures.

CASTRATION FOR ENLARGEMENT OF THE PROSTATE.

About ten or more years ago this operation was much resorted to, chiefly through the work done by Prof. J. William White,* of Philadelphia (*Ann. of Surg.*, 1893, and July, 1895).

The following are the chief of Prof. White's conclusions :

(i.) Clinical experience shows that in a very large proportion of cases (87 per cent.) rapid atrophy of the prostatic enlargement follows the operation, and that disappearance or great lessening of long-standing cystitis (52 per cent.), more or less return of vesical contractility (66 per cent.), amelioration of the most troublesome symptoms (83 per cent.), and a return to local conditions not far removed from normal (46 per cent.), may be expected in a considerable number of cases.

(ii.) The mortality is 18 per cent. If patients are operated upon under surgically favourable conditions—*i.e.*, before the actual onset of uræmia, or before the kidneys have become disorganised by backward pressure and infection—Prof. White thinks that the mortality will be only 7·1 per cent. The following appear to be some of the chief causes of a fatal issue : (1) Sepsis. This is very likely when it is difficult to prevent occasional dribbling of urine. (2) When mania or mental aberration follows. As this has followed in a fair proportion of cases, it must always be reckoned with. (3) Results of kidney failure, a complication always present in these cases, and especially to be feared when the operation is called for in long-standing and advanced cases of enlarged prostate. In such the operation will be considered by the friends to be the actual cause of death ; in reality it merely fails to save

* Frederik and Ramon had previously performed the operation (*Cent. f. Chir.*, Sept. 2, 1893), but it is to Dr. White that our profession is indebted for first collecting and publishing with unmistakable clearness the evidences, clinical, pathological, and experimental, which justified a thorough trial of the operation.

life.* (4) Causes of death common to any operation performed in the aged, such as hemiplegia and cardiac failure.

The three chief reasons for the general loss of favour of this operation in recent years are—

(1) Its high mortality. Watson (*Ann. of Surg.*, 1904, vol. xxxix. p. 853) gives the mortality of 210 of these operations as 16·2 per cent. Moreover, the death-rate did not decrease with experience. When a careful selection of cases is made, however, the results are better. Thus Mr. Mansell Moullin (*Enlargement of the Prostate*, 1904) lost only two of his 19 cases, a mortality of only a little more than 10 per cent. Atrophy occurred in all except two of those that survived, but in these two a catheter had to be used still.

(2) The uncertainty, incompleteness, and impermanence of the relief given by castration, which therefore compares very unfavourably in these respects with total enucleation of the prostate.

Freyer removed two prostates some years after castration had been performed. One of these weighed $8\frac{1}{4}$, and the other $1\frac{1}{4}$ oz.

(3) The decrease of the mortality of, and the comparative completeness of the relief afforded by, supra-pubic and perineal total prostatectomy. The death-rate of these operations, according to published results, is about 8 per cent. It must always be remembered that the real mortality of all operations is higher than the published records indicate, but this is equally true of castration, so that there is no doubt that castration is more dangerous and far less satisfactory than prostatectomy.

It is no longer true for the great majority of cases that removal of both testicles is simpler, easier, and takes less time than supra-pubic prostatectomy, and it is just those cases in which enucleation is difficult, as in small fibroid enlargements, that castration will be of little or no value. As to drainage, castration does away with the inconveniences of any fistula, and the noisome leakage which may be inseparable from it. On the other hand there is the repugnance which so many men, even when well on in life, feel towards parting with their testicles, a repugnance which we often met, and which frequently baffled us.

It must not be forgotten that all the immediate relief following double castration was due to reflex diminution of vascular congestion, and due to the enforced rest. Much of the permanent decrease of obstruction and the undoubted decrease in the size of the prostate was doubtless due to the same factors. The adenomatous growth may still continue. The following conclusions arrived at by Mr. Cuthbert Wallace (*Trans. Path. Soc. of London*, vol. lvi., Part I., 1905) after very careful experimental researches, and a thorough consideration of the clinical evidence available, are of great importance in their bearing upon this subject:

“Castration in adult life produces an atrophy of the prostate. Such an atrophy takes an appreciable time to become established. Castration, although it produces an atrophy of the normal prostate in the

* In Mr. H. Fenwick's words (*Med. Ann.*, 1896, p. 508), “there is every reason to believe that unsuitable and unfavourable cases have been chosen in the first wild rush which is so unreasonably made at every innovation. Uræmic and even dying patients have been castrated.”

course of time, is not to be depended upon to produce an appreciable atrophy, useful for the treatment of the enlarged organ.”

I quite agree with Mr. Wallace that the operation has been rightly abandoned.

Unilateral orchidectomy is unscientific, for the presence of one testis, even if the excretory duct has been divided, is sufficient for the perfect growth and nutrition of the prostate (Wallace). Therefore it is hardly to be expected that this operation would have any appreciable influence upon the enlarged prostate, and when any effect has been noticed it has been but transient, and probably of a reflex vascular origin.

VASECTOMY.

The division or removal of portions of the vasa deferentia was largely practised a few years ago as an alternative to castration for certain cases of hypertrophy of the prostate (*vide* p. 682). The chief arguments that have been advanced in favour of vasectomy are—(1) that its effect on the prostate is the same as that of castration; (2) that the operation is much less severe than castration, and therefore better borne by the type of patients who need such measures; (3) that it meets the rooted objection to loss of the testicles that many men have, even when advanced in years.

On the other hand, although some brilliant successes have been recorded, the mortality, as shown by Wood's figures (*loc. supra cit.*, p. 480), amounts to 6·7 per cent., not very much less than the present mortality of castration for enlarged prostate. Again, the improvement is usually not so great as after castration, and it is not nearly so certain; Wood's figures show that some improvement took place in only 67 per cent., as against 90 per cent. improved after castration. Finally, there is evidence that relapse takes place in some of the cases in which this operation is performed, and Freyer (*Lancet*, vol. i., 1900, p. 155) goes so far as to say that “in a very considerable proportion of the cases there has been no permanent benefit from this operation.” This might be expected from the very nature of the operation, which cannot possibly have anything like the same effect on the sexual organs generally that castration must have.

Experimental evidence has since shown that vasectomy does not lead to atrophy of either the healthy prostate or the testicle (Wallace, *loc. cit.*). Unless the sympathetic nerves and the vessels running with the vas were also severed, no appreciable effects were noticed. Atrophy of the testis follows destruction of these structures. Clinical evidence has also accumulated, and amply proved the worthlessness of this operation, which has been abandoned, and will not be described here. Secondary operations have been quite commonly required after vasectomy (Freyer, *loc. supra cit.*).

Causes of Death after Operations for Enlargement of the Prostate.

(1) Uræmia is by far the commonest; (2) shock; (3) cardiac failure; (4) ascending suppurative nephritis; (5) pelvic cellulitis, pulmonary complication, pneumonia, or bronchitis; (6) mania and other forms of insanity; (7) pulmonary embolism.

Palliative Operations.—Cystotomy may have to be performed for the relief of acute retention, intra-vesical hæmorrhage, severe cystitis, threatening uræmia, or for the removal of calculi. It is far better to adopt the supra-pubic in preference to the perineal route, which is a long and troublesome one in these cases, for acute retention. Aspiration is not suitable except merely to relieve the patient while awaiting other and more satisfactory measures. Although aspiration may be followed by such a diminution of congestion of the prostate and urethra that a catheter can be passed after a few hours, this is not to be relied upon, for a repetition of the aspiration is very likely to become

necessary again and again, with the result that some of the urine, which is usually infective, if not always foul, leaks into the pelvic cellular tissues, with disastrous results.

It is, therefore, far better, when all attempts at catheterisation have failed, to perform either supra-pubic cystotomy or supra-pubic puncture with a trocar and cannula. In either case drainage must be established, and continued until urine passes naturally, or a catheter can be introduced through the urethra. Supra-pubic cystotomy provides the best drainage, and therefore the best safeguard against renal complications and pelvic cellulitis, but supra-pubic puncture is the easiest to perform in an emergency without proper help, and the fistula closes sooner if the natural passage becomes re-established. Care must be taken, however, not to remove the supra-pubic catheter until its track is sealed off from the cellular tissues, so that extravasation may not occur. In most cases it is best to perform supra-pubic cystotomy and to drain the bladder until cystitis, congestion, and any uræmic symptoms have subsided, and then to perform supra-pubic prostatectomy, if there are no contra-indications.

PRIMARY MALIGNANT DISEASE OF THE PROSTATE.

This is a comparatively rare cause of enlargement of the prostate, although it is not so uncommon as is generally believed; and for this reason it is important to examine all prostates which are removed for supposed adenomatous enlargement. Carcinoma is by far the commonest malignant growth, and Holmes Green estimates that from 5 to 10 per cent. of the senile prostatic enlargements are carcinomatous. It occurs in men who are well advanced in years. The average age of 19 cases which were collected by Holmes Green was 68 years (*New York Med. Journ.*, Oct. 24, 1903), and of 100 cases collected by Kaufmann all were over 40, and 68 per cent. were between 50 and 70 years of age (*Hawley, Ann. of Surg.*, 1904, vol. xxxix. p. 893). Sarcoma is much less common, and occurs in younger subjects.

The carcinomatous prostate differs from the adenomatous in being nearly always much harder, and nodular upon the surface. It also gives rise to much more pain in the perinæum, penis, sciatic region, and rectum. Bleeding is also more common, and occurs more frequently apart from retention and instrumentation. Later on the iliac and groin glands may be enlarged, the rectal wall invaded, and metastasis may become evident, especially in the bones. These may appear when the primary growth is comparatively small and removable, so that it is important to examine for them.

Operations.—(a) *In late cases* either no operation is indicated, or palliative supra-pubic cystotomy may become necessary for retention of urine, but as long as the obstruction can be overcome by means of a catheter, without much pain, no operation should be undertaken. After a supra-pubic cystotomy Colt's apparatus may be used to keep the patient dry (p. 602).

((b) *In early cases.* Since Billroth's original case of perinæal extirpation in 1859 many attempts have been made to perform radical operations for malignant disease of the prostate, but most of the

attempts have been far too late, so that many have considered that operative interference is always unjustifiable. Recent results are more favourable, however. If the diagnosis is made soon, and before the disease has invaded the bladder or urethra, and in the absence of any signs of dissemination, the growth may be explored through the perinæum, and enucleated from within the fibrous sheath, if possible. If cystoscopy, has not been practicable, it will be necessary to perform supra-pubic cystotomy, in order to determine the freedom, or otherwise, of the bladder, before extirpation is attempted. In some cases it is quite impossible to pass the cystoscope through the hard and contracted prostatic urethra, but this difficulty usually arises in late cases, which are unsuitable for any radical operation.

To attempt to remove an adherent prostatic carcinoma is meddlesome surgery, and is to be heartily condemned. The only hope is in the early stage, when the diagnosis is, unfortunately, difficult.

Holmes Green and others have removed early carcinomatous prostates in mistake for so-called senile hypertrophy. In Dr. Green's case only one lobe of the gland was malignant. The patient recovered, and was well a year later, except for a small fecal fistula, the result of injury of the rectum at the operation.

Oraison reports "23 cases from the French clinics in which perinæal prostatectomy was done. In 10 of these (43 per cent.) cure has remained permanent after more than four years. In three only were there recurrences. Six others recovered, but were lost sight of; the remaining four died from the operation" (Hawley, *loc. supra cit.*).

Prostatic Abscess.—This generally opens spontaneously into the urethra, or it may be perforated by the catheter, which is introduced for the relief of acute retention of urine. In other cases it opens into the rectum, and in some it burrows back into the ischio-rectal fossa, and issues at the side of the anus.

The perinæal route is the best to choose for opening and draining the abscess, and should be adopted, if possible, before the pus has burrowed about or has given rise to pyæmia. The abscess drains but poorly along the urethra, and its discharge in this direction may be followed, in some cases, by cystitis, urethritis, or troublesome urinary fistulæ.

Dr. Alexander (*Ann. of Surg.*, 1906, vol. xlii. p. 883) opens all prostatic abscess through the prostatic urethra, into which he introduces a finger through an opening made into the membranous urethra upon a grooved staff. A finger of the other hand is introduced into the rectum as a guide, and the finger within the urethra tears through the mucous membrane and opens the abscess or dilates a pre-existing small opening. All trabeculæ are broken down, and a free opening is made. The bladder is then drained through a tube introduced into the perinæal wound. A few strips of gauze are passed alongside the tube as far as the opening into the abscess cavity, which is not packed.

Dr. Lusk (*Ann. of Surg.*, January, 1907, p. 103) objects to this method for cases in which the abscess has not already ruptured into the urethra, and prefers to open the abscess through the fore part of ischio-rectal fossa, behind the base of the triangular ligament, and between the anterior borders of the levatores ani. In this way the urethra is

not opened, and the danger of cystitis and the troubles of a urinary fistula are avoided.

I think Dr. Lusk's way is the best method for the cases indicated by him, and it is an easy and safe method. There is hardly any danger of injuring the rectum, which is separated from the wound by the levator ani and anal fascia. The structures in the perinæal triangle and those between the triangular ligament are entirely avoided, while the pudic vessels and nerves are left ensheathed by the obturator fascia in the outer wall of the ischio-rectal fossa. Dr. Alexander's method is a rapid and excellent one for late cases in which the abscess has opened into the urethra, or has burrowed down alongside the membranous urethra.

Prostatic Calculi.—These are usually small, and are best removed through a median perinæal section (*vide* p. 630).

CHAPTER XIII.

OPERATIONS ON THE URETHRA AND PENIS.

RUPTURED URETHRA. — EXTERNAL URETHROTOMY. — INTERNAL URETHROTOMY. — THE TREATMENT OF STRICTURE RETENTION. — CIRCUMCISION. — AMPUTATION OF PENIS. — EPISPADIAS. — HYPOSPADIAS.

RUPTURED URETHRA.

IN a few cases the surgeon may succeed in passing a catheter into the bladder. He is most likely to do so by keeping the point along the roof of the urethra, for this is the part which most frequently escapes injury. If the instrument enter the bladder in a case where there has been much bruising* of the perinæum and extravasation of blood, a median incision should still be made to allow of relief of tension and escape of breaking down clots, and so give good drainage. If this is not done, the probability is great that a little later, owing to damage of soft parts, tension of blood clot, and a little escape of urine by the side of the catheter, this step will be required at a time when, from the presence of septic fever, and the condition of the extravasated blood and urine, the occasion is less favourable.† Again, though a catheter can be passed at the time, it by no means follows that when, owing to it being plugged, or from some other reason, it requires removal in a few days, a fresh one can be inserted. An incision will then have to be made, and, as already stated, under conditions less favourable.‡

When, as is usually the case, a catheter cannot be passed into the bladder, the patient is placed in lithotomy position, and the parts having been shaved and cleansed, a grooved staff of as full size as the parts will admit is passed as far as it will go—i.e., to the site of the rupture; it is then made to project in the perinæum, and the surgeon, entering a straight sharp-pointed bistoury in the middle line at a point an inch to an inch and a half in front of the anus, pushes it on till it

* Complete rupture of the urethra may co-exist with a mere contusion of the perinæum, especially if much tenderness is present.

† Kaufmann (Von Bergmann's *System of Practical Surgery*), out of 44 cases, found that the catheter had to be removed in 22, for extravasation had occurred in 3. Perineal abscess had developed in 9, and extensive sloughing in 10; five of the patients died from these complications.

‡ Mr. Rutherford (*Glasgow Hosp. Rep.*) advises supra-pubic puncture in addition to any other procedure, and describes three cases in which he adopted this plan with advantage.

strikes the groove, and then cuts along this, both upwards and downwards, so as to expose freely the spot at which the urethra is ruptured. As the knife is brought out, the skin wound is enlarged till this is about an inch and a half long, the lower end being half an inch in front of the anus. I prefer to cut down upon the staff with an ordinary scalpel, although the method already given is quicker.

With the finger clots are now turned out, and, retractors being inserted deeply, the wound is sponged out thoroughly. A good deal of bleeding may now take place from some wounded vessel, hitherto closed by extravasated blood, or from the crus penis, detached on one side by the violence which ruptured the urethra, especially if there be a fractured pelvis. This hæmorrhage will yield to firm pressure or to forci-pressure. The anterior end of the urethra is next readily found by the end of the staff, which projects through it. The finding of the deeper or vesical end, often difficult, will be facilitated by careful sponging, a mirror and reflected light, pressure above the pubes, and the use of fine probes or straight gum-elastic catheters. This end often projects as a small clot or bleeding point; at other times it resembles a partly twisted artery.*

If it be found, a catheter of as large size as possible should always be introduced, if practicable, from the meatus, and then through the vesical end of the urethra into the bladder, guided by a finger in the wound, a Brodie's probe, or a Teale's gorget (Fig. 264). If this be found impracticable, a catheter should be passed into the bladder from the wound. One of these methods should always be made use of, if possible, as it enables the patient to be kept dry by tubing attached to the catheter.

But if no catheter can be got into the bladder, either along the penis or from the wound, the surgeon need not worry himself as long as a free exit has been given for the urine and extravasated blood. In these cases it is not unusual for the bladder to become somewhat distended during the first two or three days, owing to the urine not escaping with sufficient freedom, or to the closure of the vesical end of the urethra from swelling after the injury and the manipulations to find it, or from the patient, if a child, shrinking from passing his water. This difficulty will usually be met by hot flannels frequently applied to the abdomen, and a few doses of laudanum, but if it be evident that the urine does not escape with sufficient freedom, the surgeon must again examine the wound with the aid of an anæsthetic, clean out any fresh clots, and again try to find the vesical end of the urethra, aided now, perhaps, by a better light.

If this fail, supra-pubic tapping or aspiration, or if the patient's condition be good, making a small supra-pubic opening into the bladder and thence passing a short curved staff into the perinæum, and so finding the vesical end of the urethra (p. 652), must be resorted to.

Urethritis and cystitis are not uncommon in children. They are best met by, as soon as possible, leaving out the catheter for a while.

With regard to the question of trying to suture the urethra, it is always advisable, if possible, to draw the ends of the urethra together

* The farther back the tear, the greater, of course, the difficulty in finding the urethra.

on the catheter with a fine curved needle on a holder, and catgut sutures. But this will often be found a matter of great difficulty, and even impossible. When effected, it does not diminish the need of subsequent regular use of catheters, and the perinæal wound must be drained for a few days in any case, however well the surgeon may have been able to sew the urethra.

EXTERNAL URETHROTOMY (Figs. 262 to 266).

This operation includes the different forms of perinæal section with or without a guide—viz., Syme's, Wheelhouse's, and Cock's operations.

By some, **external urethrotomy** is reserved for those cases, such as Syme's, in which a staff can be passed through the stricture, and "**perinæal section**" for those in which no such help is available—*e.g.*, Mr. Cock's operation. As, however, these terms are readily confused by students, and as in Wheelhouse's operation a staff is used, though it cannot be passed through the stricture, I think it preferable to employ the term external urethrotomy, specifying which operation is meant by using the author's name—viz., Syme's external urethrotomy, &c.

Indications for External Urethrotomy.—This operation is recommended for (1) cases of impermeable stricture, for which both dilatation and internal urethrotomy are inapplicable.

(2) Cases of stricture which do not yield to dilatation, or rather continue to present symptoms after being dilated, in other words, contractile, irritable, and resilient strictures, in which dilatation is accompanied with much pain, or in which it is found that a No. 7 can perhaps be passed one day and only a No. 3 a day or two later. These are usually cases of false passages at the side of the real stricture, the instrument having been forced through the urethral wall just in front of the constriction and then back again into the dilated urethra behind.

(3) Traumatic constrictions are also sometimes very intractable with dilatation, and elongated multiple strictures are very troublesome, and are often best treated by external urethrotomy.

(4) Cases in which rigors and constitutional disturbances follow any attempt at dilatation.

(5) When fistulæ or cystitis complicate the stricture, it is best to use this operation.

Wheelhouse's operation is far more often employed than that of Syme, for the former is more generally applicable to all kinds of strictures, whereas Syme's operation needs a permeable urethra for its performance. Cock's operation is the most suitable for bad cases with acute retention, extravasation, or multiple fistulæ and diseased kidneys.

Syme's External Urethrotomy.—Here the stricture is divided on a fine staff (*vide infra*) passed through it.

Operation.—The patient, having been prepared by mild aperients and bland liquid diet for the operation, is brought under an anæsthetic, and while his legs hang over the end of the table the surgeon introduces a Syme's staff. This has a narrow terminal portion which passes through the stricture, a shoulder which rests upon the face of the stricture, and a wider, stouter part above the shoulder to make the

instrument easier to find in the perinæum. The patient being placed, in a good light, in lithotomy position, and the parts cleansed and shaved, the surgeon makes an incision exactly in the median line down upon the staff, exposing the wider portion above the shoulder. When the surgeon is certain that this is laid bare, he runs the knife forwards along the groove, so as to divide the stricture completely. The staff is now withdrawn, and the rest of the treatment must vary somewhat. If the condition of the patient admits of it, a full-sized gum-elastic catheter should be passed from the meatus into the bladder, guided by a finger in the wound or in the rectum, or by a grooved director passed from the perinæum. If the irritability of the parts does not admit of this, a gum-elastic catheter must be inserted from the perinæum, cut short, and kept *in situ* with tapes, the urine running off, by tubing attached, into a basin containing carbolic acid lotion; or Prof. Syme's curved perinæal catheter may be employed.

FIG. 262.



(Wheelhouse.)

As soon as a catheter can be passed from the meatus, it should be kept in for two or three days, and changed, if needful, with an anæsthetic at first. As soon as possible it should be passed twice a day, and the patient should be clearly told of the absolute necessity which exists of keeping up the good effects of the operation by the passage of an instrument at regular intervals, and of occasionally reporting himself to his surgeon.

Wheelhouse's External Urethrotomy.—Here the stricture is first found by a staff passed down to it, and then divided on a fine probe-pointed director passed through it.

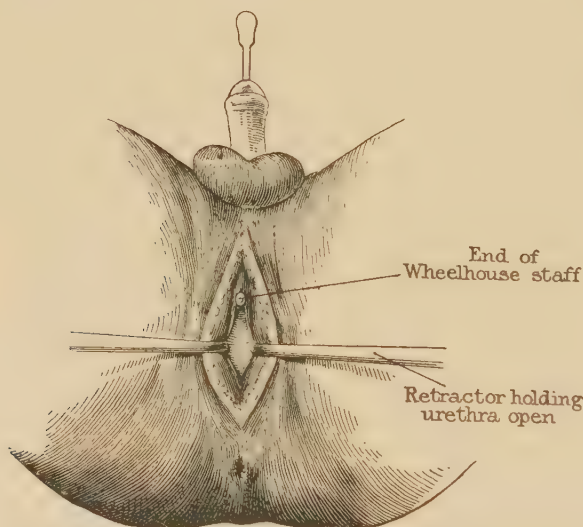
Mr. Wheelhouse (*Brit. Med. Journ.*, June 24, 1876) recommends his method as having "the advantage of greatly increased precision. It renders an operation, confessedly hitherto one of the most difficult in surgery, a comparatively easy one, and one which, in my hands and in those of my colleagues, has given results infinitely more favourable, with an immediate and ultimate effect upon our cases, than we had ever seen before its introduction."

Operation.—"The patient is placed in lithotomy position, with the pelvis a little elevated, so as to permit the light to fall well upon it, and into the ground to be made. The staff* (Fig. 262) is to be introduced with the groove looking toward the surface and brought gently into contact with the stricture. It should not be pressed much against the stricture, for fear of tearing the tissues of the urethra and causing it to leave the canal, which would mar the whole after-proceedings, which depend upon the urethra being opened *a quarter of an inch in front of the stricture*. Whilst an assistant holds the staff in this position, an incision is made into the perinæum, extending from opposite the point of reflection of the superficial fascia to the outer edge of the

* This is fully grooved through the greater part, but not through the whole of its extent, the last half-inch of the groove being "stopped" and terminating in a round button-like end.

sphincter ani. The tissues of the perinæum are to be steadily divided until the urethra is reached. This is now to be opened, *in the groove* of the staff, *not upon its point*, so as certainly to secure a quarter of an inch of healthy tube immediately in front of the stricture. As soon as the urethra is opened, and the groove in the staff fully exposed, the

FIG. 263.



Wheelhouse's operation. The urethra has been opened in front of the stricture.
(After Wheelhouse.)

edges of the healthy urethra are to be seized on each side with straight-bladed nibbed forceps and held apart. The staff is then to be gently withdrawn until the button-point appears in the wound. It is then to

FIG. 264.



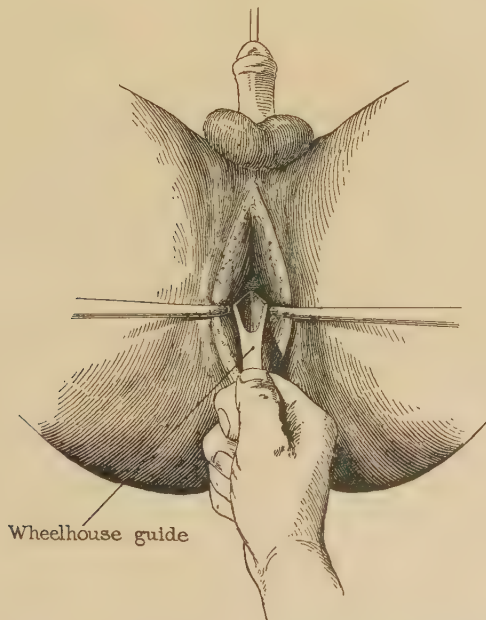
Teale's probe-gorget.

be turned round, so that the groove may look to the pubes, and the button may be hooked on to the upper angle of the opened urethra, which is then held stretched open at three points thus (Fig. 263), and the operator looks into it immediately in front of the stricture. While thus held open, a probe-pointed director* is inserted into the urethra, and the operator, if he cannot see the opening of the stricture, which is often possible, generally succeeds in very quickly finding it, and passes the point onwards *through* the stricture towards the bladder. The stricture is sometimes hidden amongst a crop of granulations or warty growths, in the midst of

* Or a common blunt-pointed probe may be used. Occasionally a bougie (No. 2 or 3) is useful.

which the probe-point easily finds the true passage. The director having been passed into the bladder (its entrance into which is clearly demonstrated by the freedom of its movements), its groove is turned downwards, the whole length of the stricture is carefully and deliberately divided on its under-surface, and the passage is thus cleared. The director is still held in the same position, and a straight probe-pointed bistoury is run along the groove to ensure complete division of all bands or other obstructions. These having been thoroughly cleared, the old difficulty of directing the point of a catheter through the divided stricture and onwards into the bladder is to be overcome. To effect this, the point of a probe-gorget (Fig. 264) is introduced into the groove

FIG. 265.



Wheelhouse's operation. The probe-gorget is used to guide the catheter into the bladder. (After Wheelhouse.)

in the director, and, guided by it, is passed onwards into the bladder dilating the divided stricture, and forming a metallic floor, along which the point of the catheter cannot fail to pass securely into the bladder. The entry of the gorget into the latter viscus is signalled by an immediate gush of urine along it. A silver catheter* (No. 10 or 11) is now passed from the meatus down into the wound, is made to pass once or twice through the divided urethra, where it can be seen in the wound, to render certain the fact that no obstructing bands have been left undivided, and is then, guided by the probe-gorget, passed easily and certainly along the posterior part of the urethra into the bladder (Fig. 265). The gorget is now withdrawn, the catheter fastened in

* A soft catheter is better and safer to tie in.

the urethra and allowed to remain for three or four days, an elastic tube conveying the urine away. After three or four days the catheter is removed, and is then passed daily, or every second or third day, according to circumstances, until the wound in the perinæum is healed; and after the parts have become consolidated it requires, of course, to be passed still from time to time, to prevent recontraction.”*

This will be found a most effectual operation, but in many cases the hitting off of the mouth of the stricture is a less simple matter than would be gathered from Mr. Wheelhouse's account. This is especially the case when the parts are engorged and softened, as the free oozing which is met with under these conditions may be most difficult to arrest even with firmly applied sponges on holders, the slightest trickling of blood being sufficient to obscure the orifice of the stricture. A false passage at the site of the stricture may complicate matters very much, and a stricture in the penile portion of the urethra may prevent the passage of the staff altogether. A good light, gentleness, and patience are at all times requisite.

Occasionally a firm nodular or traumatic stricture may be excised after König's method, the urethral ends being sutured as for ruptured urethra. In other cases a good deal of periurethral scar tissue may be dissected away with the object of lessening the chance of recurrence of the stricture. Grafting operations for the reconstruction of the urethra after more extensive resections or traumatic destruction have not been attended with encouraging success.

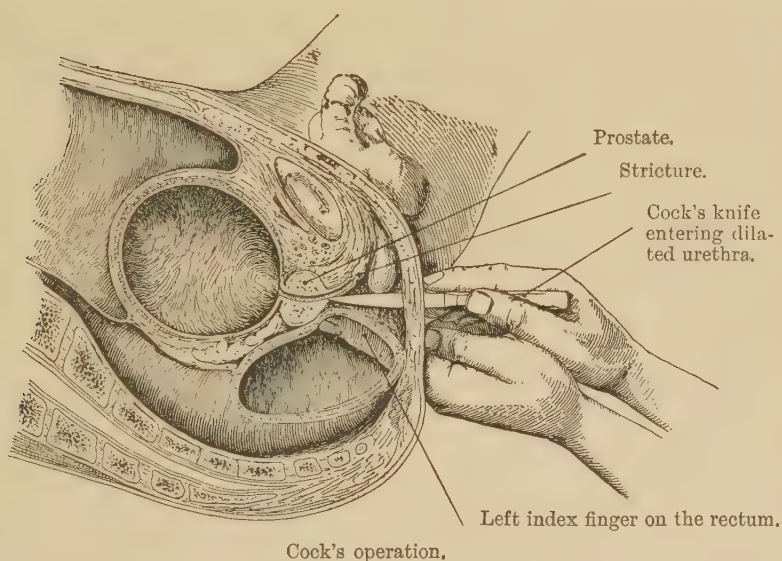
Cock's Operation.—An external urethrotomy, which opens the urethra behind the stricture, and without a guide (Fig. 266). The following, in the words of its deviser, are the *advantages* of this operation, so well known to Guy's men (*Guy's Hosp. Reports*, 1866, vol. xii. p. 267): “The bladder is reached without any unnecessary mutilation of the perinæum. The communication is effected in nearly a straight line from the exterior to the cavity of the viscus, so that the cannula, which is inserted and retained, can be removed whenever necessary, and can be easily replaced. The functions of the entire urethra are suspended, and may be kept in abeyance for an unlimited period. The urine no longer finds its way abnormally through the stricture and sinuses of the perinæum. The tissues are no longer subjected to constant irritation from infiltration. The constitutional symptoms are relieved, and time and opportunity are given for the removal by absorption of those adventitious products which obstructed the urethra, indurated the perinæum, and rendered the introduction of an instrument impossible. The pressure on the kidneys is removed, and, if expedient, the bladder may be readily washed out, until its lining membrane assumes a healthy character. The strictured and damaged portion of the urethra being no longer subjected to the constant pressure of urine from behind, may probably so far recover itself as to allow of restoration by the ordinary means of dilatation; or, should the canal have become permanently obliterated, the patient still

* The wound should be syringed occasionally during the operation with a dilute solution of mercury perchloride, and a little iodoform dusted in at the close. If any bleeding is going on, the wound should be plugged around the catheter with strips of iodoform gauze.

retains the means of emptying his bladder through the artificial opening without difficulty or distress, and at very moderate inconvenience to himself."

The following are the cases to which the operation is well suited: where the stricture has existed for a number of years; where the urethra has become permanently obstructed or destroyed by the constant pressure of urine from behind, and by reiterated attempts, generally fruitless, to introduce an instrument; where extravasation into the perinæum has again and again taken place, causing repeated abscesses and their consequences, the formation of urinary sinuses and fistulæ, until the normal textures of the perinæum become obliterated,

FIG. 266.



and are replaced by an indurated, gristly structure; where the bladder has become thickened and contracted by the constant action of its muscular coat until little or no cavity is left; and where the urine is constantly distilling by drops either through the urethra or through one or several fistulous openings, which dot the surface of the perinæum, penetrate through the indurated scrotum, and even find their way to the nates below, and the region of the pubes above. If unrelieved, these cases invariably terminate fatally. Fortunately they are uncommon at the present day. Cases of stricture with acute retention and extravasation of urine are very quickly and easily relieved by the operation, for the urethra is distended behind the stricture.

The keystone of the whole proceeding is the fact that, "however complicated may be the derangement of the perinæum, and however extensive the obstruction of the urethra, one portion of the canal behind the stricture is always healthy, often dilated, and accessible to the knife of the surgeon. I mean that portion of the urethra which emerges from the apex of the prostate—a part which is never the

subject of stricture, and whose exact anatomical position may be brought under the recognition of the finger of the operator."

Operation.—The patient is to be placed in the usual position for lithotomy; and it is of the utmost importance that the body and pelvis should be straight, so that the median line may be accurately preserved. The left forefinger of the operator is then introduced into the rectum, the bearings of the prostate are next examined and ascertained, and the tip of the finger is lodged at the apex of the gland. The knife* is then plunged steadily, but boldly, into the median line of the perinæum, and carried on in a direction towards the tip of the left forefinger, which lies in the rectum. At the same time, by an upward and downward movement, the vertical incision may be carried in the median line to any extent that is considered desirable. The lower extremity of the wound should come to within half an inch of the anus.

"The knife should never be withdrawn in its progress towards the apex of the prostate, but its onward course must be steadily maintained, until its point can be felt in close proximity to the tip of the left forefinger. When the operator has fully assured himself as to the relative position of his finger, the apex of the prostate, and the point of his knife, the latter is to be advanced with a section somewhat obliquely either to the right or the left, and it can hardly fail to pierce the urethra where the latter is distended and enlarged between the prostate and the stricture. If, in this step of the operation, the anterior extremity of the prostate should be somewhat incised, it is a matter of no consequence.

"In this operation it is of the utmost importance that the knife be not removed from the wound, and that no deviation be made from its original direction until the object is accomplished. If the knife be prematurely removed, it will probably, when reinserted, make a fresh incision and complicate the desired result. It will be seen that the wound, when completed, represents a triangle, the base being the external vertical incision through the perinæum, while the apex, and consequently the point of the knife, impinges on the prostate. This shape of the wound facilitates the next step of the operation.

"The knife is now withdrawn, but the left forefinger is still retained in the rectum. The probe-pointed director is carried through the wound, and, guided by the left forefinger, enters the urethra, and is passed into the bladder. A No. 12 gum-elastic catheter, straightened on its stylet, is slid along the director, the stylet then removed, the catheter cut short, and secured in position with tapes."

While most fully alive to the excellence of this operation both as to speediness of relief and the perfect rest it gives to damaged parts, I should like to point out to those who are only likely to perform it occasionally (*a*) that it is not such an easy operation as it appears; (*b*) that it is a severer operation than the size of the wound would suggest. Hæmorrhage is not very uncommon from the engorged condition of the parts, and a low form of septic phlebitis is not very infrequent after the operation. For these reasons I would restrict it to the cases mentioned at p. 695.

* Cock's knife is double-edged.

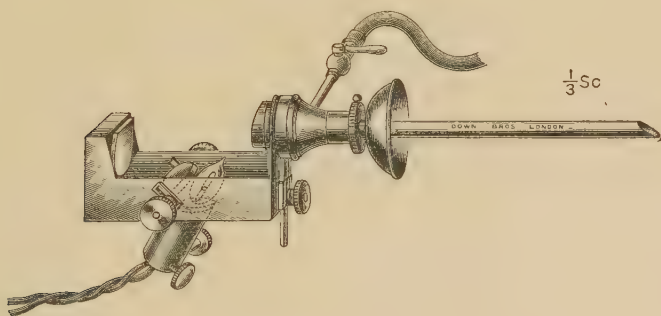
Complications and Causes of Failure after External Urethrotomy.

—1. Hæmorrhage (footnote, p. 694). 2. Rigors. These should be met by warmth; leaving out the catheter or substituting a softer one; plenty of diluent drinks; washing out the bladder with diluted Thompson's fluid (p. 623), Dover's powders, or small injections of morphia, if the condition of the kidney admits of these. Five or ten grains of quinine may be given in milk every two or three hours, if it does not excite vomiting. 3. Septic trouble—*e.g.*, septic phlebitis. 4. Pelvic cellulitis. 5. Persistence of a fistulous opening in the perinæum. 6. Recurrence of the contraction.

THE TREATMENT OF STRICTURE-RETENTION.

When the obstruction is not quite complete, or the need for relief very urgent, a few hours' rest in bed, opium, warm hip baths, or fomentations often succeed in enabling the patient to pass water and

FIG. 267.



Wyndham Powell's urethroscope. (Down Brothers.)

empty his bladder either partially or completely. Then, if not before, a small soft catheter (size $\frac{1}{2}$ to 3 silk web, or soft black) can generally be passed and tied in. The stricture soon dilates sufficiently to allow the urine to pass by the side of the catheter, if the latter fails to drain. Once he has succeeded in passing even the smallest catheter or bougie the surgeon must not remove it in the hope of being able to introduce a larger one, for he may then find that he cannot even reinsert the original one. After one or two days a larger instrument can be passed if used immediately after the withdrawal of the first one. Larger instruments can be tied in daily until the dilatation is completed.

The introduction of the catheter may be greatly aided by injecting a solution of adrenalin chloride ($\frac{1}{1000}$) into the urethra to diminish the congestion of the mucous membrane at the stricture. Distension of the urethra with warm sterile olive oil is also useful. The oil is kept in during the passing of the catheter by holding the meatus firmly against the instrument. The distension serves to remove folds of mucous membrane, to slightly dilate the stricture, and especially to displace the orifice backwards, so that it lies at the apex of the funnel formed by the urethra in front of it. Without distension of the anterior urethra the stricture

often projects forwards perhaps eccentrically into the lumen like an intussusception. So that a catheter fails to enter an opening which is quite large enough when its position is corrected.

Failing the introduction of a fine catheter, filiform bougies may be tried, and with perseverance one of these can be passed in most cases, with the aids mentioned above. The urethroscope may be useful in localising the orifice and also in conducting and introducing the bougie with the aid of sight. Sometimes a catheter can be passed upstream as the patient succeeds in voiding a little urine. Once a bougie has been got through the stricture, it may either be tied in or used as a guide for a "tunnel" or "railway" catheter to run along.

A conical silver catheter can be screwed on to a suitable bougie and slowly made to follow the latter into the bladder without any risk of making a false passage. The bougie coils safely within the bladder. This plan is far better than to attempt to forcibly dilate stricture with a metal catheter without any guide. In most cases such attempts either fail altogether or succeed only by making a false passage by the side of the real canal of the stricture. By keeping the point in the middle line a skilful surgeon may direct his instrument back again into the urethra where the latter is fortunately dilated behind the stricture, but although a good anatomist may succeed in entering the bladder and in affording immediate relief in this way, the method is too dangerous to be recommended for general use, and, moreover, the ultimate results are often poor, for the false passage usually recontracts, and obstruction returns sooner or later. Such false passages are sometimes misnamed resilient strictures.

In most cases where the patient is still comparatively young, where the stricture is not of long duration, where there are no urinary fistulæ or a damaged perinæum, the retention can be relieved and the cure of the stricture started in one of the ways mentioned above, but in others all such attempts may fail, especially owing to the existence of recently made false passages and hæmorrhage from injudicious instrumentation.

It will have been gathered from the remarks at p. 657 that **supra-pubic aspiration** may be used in very urgent cases, and may be repeated safely once if necessary. For the large majority of cases of acute and complete retention due to impermeable stricture, especially when the patient is under 45; and a few days' rest will ensure the passage of a catheter, I believe that supra-pubic tapping of the bladder will be the safest and simplest operation (p. 658). This will be followed in four or five days by the passage of a catheter, aided by an anæsthetic perhaps. Wheelhouse's operation is very highly spoken of by the Leeds surgeons. A good light and especial instruments are essential. The cases to which Mr. Cock's excellent operation should be limited have been already pointed out (p. 695).

INTERNAL URETHROTOMY.

Indications.—Before specifying these, I would say that with regard to the question between external and internal urethrotomy, or the need of either, it is chiefly a matter of personal experience. In other words, surgeons who practise usually some such operation as that of Prof. Syme—or use Mr. Wheelhouse's method—when careful dilatation, aided

by an anæsthetic, fails, will probably have as good results as those who resort to internal urethrotomy. As it is a clean division of the entire stricture which is required, this can be effected most readily, and with less practice, and with simpler instruments, by external urethrotomy; but internal urethrotomy has the great advantage of avoiding a urinary fistula except as a very rare complication. But it must be remembered that, after all, it is not so much the division of the stricture, whether from without or within, which will be curative, as the amount of perseverance which the patient shows afterwards. Again, at the commencement of internal urethrotomy each stricture must be dilated sufficiently to admit, in the case of an instrument cutting from without inwards, a split sound equivalent to No. 2 English, while in instruments cutting in the opposite direction the bulb is as large as No. 4 or 5. This being so, the cases must be very few in which the surgeon does not find it possible, and in which the patient does not prefer, to complete the case by dilatation.

Amongst these few cases are—1. Strictures localised and annular, which (*a*) contract rapidly after dilatation, or (*β*) in which rigors persistently follow attempts at dilatation. 2. Non-dilatable strictures—*e.g.*, some traumatic ones. 3. Penile strictures. These are very elastic, and shrink quickly after dilatation, and incision of these strictures seldom causes serious constitutional disturbance. 4. In some cases where time is an object. Thus, in young subjects whose disease has not existed long enough to alter the condition of the kidneys, cutting may be admissible for a stricture that should be simply dilated in an older patient whose kidneys have undergone degeneration (Berkeley Hill, *Dict. of Surg.*, vol. ii. p. 727). 5. According to some (Berkeley Hill, *loc. supra cit.*), urethrotomy affords a longer interval of freedom from contraction than does any other plan of widening a stricture. The urethroscope may occasionally afford useful information which may not only enable the surgeon to decide upon internal urethrotomy, but also indicate the exact direction and degree of the interference that is necessary. The operation can be carried out through the urethroscopic tube, with the aid of direct vision in some cases.

Contra-indications.

1. Strictures not localised and ring-like, but extending over a considerable surface. 2. A “stricture” in which the difficulty is mainly due to congestion,* though this is scarcely a stricture at all. 3. A stricture accompanied by urethritis.

I have endeavoured to point out fairly the indications for internal urethrotomy. I suspect that this is one of those operations of which an increasingly frequent use is liable to lead to something very like abuse. But, however this may be, I should like to point out first a fallacy, as it seems to me. Thus, Sir H. Thompson (*Dis. of Urin. Organs*, p. 40) speaks of a urethrotome as “nothing more than a little knife with a long blade . . . used precisely as we use a scalpel anywhere else. Just as we should use a small knife in tenotomy without the sense of

* As bearing upon the allied condition of “spasm,” the late Mr. B. Hill (*Brit. Med. Journ.*, 1879, vol. ii. p. 856) stated that if an apparently narrow bulbo-membranous and a penile stricture co-exist, on the latter being properly divided, the former will disappear, having been due to reflex muscular contraction.

vision where it is not necessary, but guided by the sense of touch, so do I advise you to act in urethrotomy." No doubt this comparison is correct as far as it goes, but its very simplicity is misleading. There can be no real comparison, I maintain, between division of a tendon, which can always be practically made subcutaneous, and that of a stricture, perhaps four inches from the surface, surrounded by vascular tissue, incision of which may easily lead to hæmorrhage or septic trouble, an incision which cannot from the subsequent flow of urine be completed aseptically, and which implicates other parts in such intimate sympathy with that operated on—*e.g.*, the kidneys.

Again, I would point out that internal urethrotomy is not the simple affair that it is sometimes represented to be. I would refer my readers to the experience of one whose name is associated with this operation. Mr. Berkeley Hill (*Lancet*, April 8, 1876, p. 524) speaks thus of a trial which he gave to the method of treating early stricture by Otis's operation of internal urethrotomy:

"All the cases operated on were those of long-standing gleet, with contraction in one or more parts of the spongy urethra, and had undergone multifarious treatment. The number of patients is sixteen, fifteen of my own and one of Dr. Otis's. In five cases the gleet stopped after the operation, and the patient was at the last report—taken in none less than three weeks, in most some months, after the operation—able to pass a bougie of the estimated size of the urethra. In short, they may be claimed as cures. But of these five the operation was serious to two: one had free bleeding for three days, the other three attacks of rigors. Of the remaining eleven, among whom Dr. Otis's own operation must be included, the gleet persisted in all; in several the urethra shrank again to its size before the operation, and in some very serious complications ensued. In four bleeding lasted several days, and in one was alarming. Three patients had rigors. In two the shivering was unimportant, being that which follows the first transit of urine along the incised urethra in certain individuals, but is not repeated or attended by further consequences; in the third patient the rigors preceded abscess in the buttock. One patient had orchitis. Thus in seven the operation might fairly be termed a trifle, causing no pain nor any after-fever, but in five only was the operation successful."

In skilful hands at the present day the dangers of the operation are very small when aseptic precautions are carefully observed. Consequently it has become more popular of late, and it gives good results when the after-treatment is properly carried out.

Complications.—(1) Hæmorrhage. If severe this may be met by pressure on the perinæum, with a pad or a stick in the bed, so that the patient may keep up the compression himself. (2) Perinæal abscess. (3) Sloughing and perinæal fistula. These are very rare. (4) Extravasation. (5) Septicæmia. (6) Epididymitis. The first five of these are usually due to cutting too deeply, or to the patient not being sufficiently prepared or unfit for the operation. The last is usually brought about by injudicious haste in the use of bougies.

The essentials of a good urethrotome are—(1) a guide through the stricture into the bladder, usually in the form of a filiform guide-bougie, or of a curved terminal portion of the urethrotome, sufficiently fine to pass through the narrowest stricture; (2) a cutting edge which, at

first shielded, can be protruded by the surgeon as exactly as he desires ; (3) some means of steadying the mobile stricture fibres as they are divided.

Two Chief Modes of Internal Urethrotomy.—The stricture may be divided—(a) from without inwards, *i.e.*, towards the bladder ; (b) from within outwards, away from the bladder. A short account of the chief instruments will be given, and the two methods briefly contrasted.

a. Those cutting from without inwards.—By this means narrower strictures can be divided than in the other method, in which the instruments used are generally based on Civiale's pattern, in which the bulbous end carries the knife.

Most of the urethrotomes which cut from without inwards are modifications of Maisonneuve's pattern. A fine hollow staff being guided through the stricture by a filiform bougie, along the hollow staff a stylet carrying a triangular shield or wedge is run ; this, pushed against the stricture, serves to steady it, while it is divided by a knife concealed in the wedge or shield.

One of the best known of the instruments on this pattern is the late Mr. B. Hill's. It consists of a narrow split sound, No. 2 English, which can be guided through narrow tortuous strictures by being attached to a filiform bougie previously passed into the bladder.* Secondly, a wedge runs along dovetail grooves between the halves of the split sound. In this wedge is concealed a knife that can be protruded between the halves of the split sound when the stricture-tissue prevents their separation sufficiently to allow the wedge to pass on. The wedge,† pushed up to the situation of the stricture, in separating the split sound tightens and steadies the stricture thoroughly, while the knife divides it to the width required by the wedge to pass along.‡ If a wedge be chosen to expand the urethra to its full natural capacity the cut will not pass beyond the stricture into the vascular erectile tissue external to it. The knife can be applied to the upper or under-surface of the stricture, as preferred.

b. Those cutting from within outwards.—A good representative of these instruments is Sir H. Thompson's modification of Civiale's urethrotome. This has a bulbous extremity, from which the blade is protruded. The stricture being sufficiently dilated to admit a No. 4 or 5 bougie, the bulb (which forms a useful sound) is carried about one-third of an inch beyond the stricture, the knife projected, and the incision made by drawing it slowly and firmly outwards—to the distance of half an inch to two inches—generally along the floor of the urethra, so as to incise the stricture freely. A metallic bougie is then passed, and if at any point it is held closely, there is still almost certainly some spot which needs touching with the blade.

* If it is doubtful whether the guide has reached the bladder, Mr. Hill advised to screw on a No. $\frac{1}{2}$ flexible catheter to the guide, and to push the whole onwards till the catheter has passed eight inches inwards. A small exhausting syringe is then applied to the catheter, and a few drops of urine drawn through it.

† The meatus must be divided, if too small to admit the wedge.

‡ After the first cut the knife is withdrawn within the wedge, and only protruded when a tight band opposes the free passage of the wedge.

After-treatment.—This varies very much. Some surgeons—*e.g.*, Sir H. Thompson and Mr. Harrison—pass at once and tie in a full-sized catheter for twenty-four or forty-eight hours, passing after this a full-sized instrument at intervals. Others—*e.g.*, Mr. B. Hill—draw off the urine with a full-sized catheter after division of the stricture, but tie none in. The patient is ordered not to micturate for eight hours if possible. By this time the incision is protected by clot and plastic lymph, and when the bladder must be emptied, the patient passes water in a hot bath, pain, spasm, and risk of tearing open the wound being thus avoided. The patient is kept in bed for ten days, and about the eighth day a full-sized bougie is passed, this period of rest being insisted upon to avoid pain, bleeding, and suppuration.

Comparison of the Two Methods of Internal Urethrotomy.—With the instruments which cut from without inwards, guided by a filiform bougie, narrower strictures can be attacked than by the bulbous-ended urethrotome, cutting in the reverse direction. These latter have been recommended as having the advantage of steadying the fibres to be cut by their pulling forwards the parts which attach the urethra to the pelvis as the bulbous end of the instrument is drawn out. The stricture is thus pulled on by the instrument until the divided stricture gives free passage to the bulbous shield and the knife protruded from it. Mr. B. Hill, however, considered that “reliance cannot be placed on the simple straining of these attachments ensuring perfect division of the stricture tissue. A Civiale’s or any other urethrotome which cuts from within outwards is very apt to wriggle its way through a stricture, only scoring it, but not perfectly severing its fibres, and to meet this difficulty the knife is often carried more deeply than is necessary.” Mr. Hill further believes that by cutting from without inwards there is less risk “of making an incision through a thin layer of fibrous tissue into erectile tissue, in the belief that a thick layer of fibrous tissue exists,” and thus of causing free hæmorrhage.

While myself usually practising what, on the whole, I believe to be preferable, continuous dilatation, aided, if need be, by external urethrotomy, I have, I trust, here fairly dealt with internal urethrotomy. Before leaving this matter I should like to allude to the question of time. Internal urethrotomy no doubt saves time and trouble also, but it must not be thought that the saving is a large one. Thus, with regard to time, Mr. B. Hill wrote*: “It is indispensable that the patient lie in bed continuously for at least ten days, and keep his room for fourteen days.” Subsequent regular passage of a bougie is as needful after internal urethrotomy as any other mode of treating stricture.

ECTOPIA VESICÆ AND EPISPADIAS.

The various plans that have been devised for the relief of this most miserable condition may practically be divided into three groups. The first group consists of plastic operations, which aim at the formation of a new anterior vesical wall and urethra. The method associated with the name of Wood has been most widely adopted. As will be seen by reference to the description given below, the anterior wall of

* *Dict. of Surg.*, vol. ii, p. 729. See also the lectures, alike candid and helpful in detail, by the same surgeon (*Brit. Med. Journ.*, 1879, vol. ii. pp. 763 *et seq.*).

the bladder is formed by skin-flaps. The advantages gained by the operation, if successful, are that a receptacle for the urine is formed, and that the exposed mucous membrane is covered in and protected; but unfortunately the most important lower part, where the ureters discharge, pouts and remains exposed to as much irritation as ever. *Fistulæ* are common even after repeated operations, and then the patient is very little better off than before, because the urine cannot be collected satisfactorily by a urinal. It is important to remember that no sphincter can be provided, and therefore no control, so that a urinal must be worn constantly as before, even in the most successful cases.* In these cases the patients can be kept dry during the day, and some of them also at night, but the best urinal is an offence and a danger. In a few cases the urine has been retained for an hour or two, but various mechanical contrivances designed for increasing the retaining power have not been attended with more than temporary success as a rule. Moreover, with the growth of hair into the bladder cystitis is set up, and the hairs are constantly the seat of phosphatic deposit which will probably have to be removed at intervals.

Attempts have, however, been made to form the new bladder of mucous membrane instead of skin, but stones have formed even when the whole of the new bladder has been lined with mucous membrane either of intestinal or vesical origin.

Tizzoni and Poggi successfully removed the bladder of a dog and replaced it by a new bladder formed from a piece of small intestine, which they left attached to its mesentery after having cut it out of the circuit of the alimentary canal. Rutkowski (*Centr. für Chir.*, No. 16, 1899), acting on this suggestion, successfully made use of an intestinal flap for ectopia in a boy aged 9.

The following account of the operation is given by Warbasse (*Ann. of Surg.*, August, 1899):

"A median incision, six centimetres long, was made, terminating below at the bladder. After opening the abdomen, a coil of ileum was brought out and divided at two points, six centimetres apart. This six centimetres of intestine was isolated. The intestine was united by an end to end anastomosis with two rows of continuous silk suture, and replaced in the abdomen. The excised segment was divided longitudinally opposite its mesentery, thus forming a quadrilateral flap about forty square centimetres in size, attached to the mesentery along its middle. After detaching the bladder from the abdominal wall and enlarging the bladder opening, the intestinal flap was sutured by two rows of running suture into the defect. The deeper suture of catgut included the entire thickness of the bladder and intestinal walls, with the exception of the mucosa. The outer suture of silk was applied as a Lembert suture. This gave a urinary bladder with an anterior wall formed from intestinal flap receiving its nourishment through its own segment of mesentery. Over the whole the abdominal wall was closed. A catheter was left in the urethra for permanent drainage of the bladder. The operation lasted an hour and a half. The condition of the patient immediately after the operation was excellent. The post-operative course of the case was ideal, entirely afebrile. The wound healed per primam. On the tenth day the sutures were removed. Eight weeks after the operation the patient was able to retain twenty-five cubic centimetres of urine in the bladder. Under pressure this amount could be increased to thirty cubic centimetres."

* In a few cases the new-formed bladder has been capable of retaining the urine for several hours, notably one recorded by Trendelenburg, but the fact remains that no satisfactory living sphincter has been constructed. Stones are most likely to form in the most continent bladders.

In the second group of operations no attempt is made either to construct a bladder, or to provide an alternative and controllable receptacle, but the ureters are transplanted into the urethral gutter, so that the urine can be conducted more easily into a urinal. This operation is more successful than the more elaborate flap methods, although it is less ambitious.

In the third group of operations no attempt is made to form a bladder, but the course of the urine is diverted into the bowel, which thus becomes the receptacle for the urine.

A number of surgeons have excised the vesical mucous membrane and implanted the ureters in the rectum or sigmoid. The chief objection to this is the liability to infection of the ureters from the bowel, resulting in ascending nephritis. Maydl has, however, largely overcome the risk of infection by implanting the whole trigone into the rectum, thus retaining the valvular orifices of the ureters. Brandsford Lewis (*Ann. of Surg.*, June, 1900), in a review of this subject, quotes a number of cases operated on by Maydl's method. The following case, operated upon by Dr. Herezel, of Buda-Pesth, will serve to illustrate what may be hoped for as a result of this operation :

"A boy five years old was operated on in May, 1897. In March, 1898, his condition was reported by the operator as admirable. Quantity of urine 1,000—1,200 cubic centimetres in twenty-four hours; specific gravity 1,013; slight amount of albumen, no pus. The boy was able to hold the urine five hours at a time, and then to eject it in a good stream from the rectum. In August, 1899 (a year and a half after the operation), the condition continued as satisfactory. The patient, now a rapidly growing and strengthening boy, enjoyed living, retaining his urine for six or seven hours during the day-time, but relieving himself oftener at night, or running the risk of wetting the bed while in deep sleep."

The same author also quotes the results of seventeen operations by Maydl's method, collected by Nové-Josserand. There were two deaths, one from shock and the other from infection. "The secondary accidents noted were fistulæ of the urinary passages with an accompanying localised peritonitis, all of which cases recovered. Pyelonephritis, as the result of ascending infection, resulted in the death of one case after a period of four months. Urinary continence was perfect in all the cases excepting two. The patients were able to hold their urine for at least three hours, sometimes six or seven hours, and in one case throughout the night. The urine was voided sometimes mixed with faecal matter, sometimes alone. The tolerance of the rectal membrane was perfect."

Dr. Watson (*Ann. of Surg.*, 1905, vol. xlii. p. 813) collected 42 cases of Maydl's operation, and found that nine deaths had occurred (mortality 21 per cent.) and that three of the deaths were attributable to the rectal implantation *per se*.

Dr. Hartley (*Med. News*, Aug. 29, 1903) refers to 46 cases, with a mortality of 15 per cent.

Orloff (*Ann. de Mal. de Gen. Urin.*, No. 11, 1902) collected 56 cases, with eleven deaths (mortality 17 per cent.), within twenty-one days.

Although the danger of death from ascending septic infection of the kidneys is very much less than with direct implantation of the ureters without preservation of their valvular orifices, yet the risk is a real and

considerable one. Some of the patients have died from this cause within a few weeks, and others after one or more years. The dangers of shock and peritonitis are also great, for the operation is a long and difficult one, which has sometimes taken over two hours to perform.

Four of the deaths in Orloff's collection were due to peritonitis, two to pneumonia, one to the anæsthetic, and one to hæmorrhage. Of the forty-five who survived the operation five died later from ascending infection. Of Orloff's own four cases one died from this cause in a fortnight, and another after two years. It is fair to state, however, that a number of these patients were already suffering more or less from renal changes at the time of the operation.

Function.—The rule is that the rectum gradually or even rapidly acquires the power of retaining the urine, for several hours, without any appreciable sign of irritation. During the day the control is almost perfect, but incontinence or reflex evacuation is not uncommon at night. Nine of the cases collected by Hartley had been seen three years after the operation, and one after seven years. Thirteen had been seen two years after the operation.

Complications and Sequelæ.—Seven of Orloff's collected cases had developed fæcal fistulæ, and in three of these a secondary operation became necessary on this account. Pneumonia occurred in six of Orloff's cases, with two deaths. In one case obstructive kinking of the ureters has caused death.

In spite of the fact that this operation is undoubtedly more severe than the plastic method, the immediate and the late results, in those that survive, are far better than those of the best of the older methods. The mortality of the operation is really greater than the figures quoted above would indicate, and time has shown that the late results are not so perfect as some surgeons anticipated, because ascending infection has not been uncommon. It must be remembered, however, that renal infection has been frequent after plastic operations, and that the condition of these patients, if left alone or submitted to plastic operation, is truly miserable, so that it is worth while to run a considerable risk to gain a tolerable result.

Operations. (1.) The construction of a bladder:—

(a) Wood's plastic method, and some modifications of it; (b) Trendelenburg's operation; (2) Sonnenburg's operation; (3) The diversion of the urinary stream into the intestine: (a) Frank's method; (b) Maydl's method; (c) Moynihan's method.

(1a) Wood's Operation.

Age.—The cure of the ectopia may be commenced after the child is four or five, and should be completed, if possible, by puberty. In this case the epispadias may be taken in hand and completed before adolescence, when the growth of hairs and sexual desires will interfere much with the union of the flaps.

*Unfavourable Conditions.**—1. Large size of the ectopia, with much bleeding and some purulent discharge from the surface. 2. A sickly condition of the patient, pointing to poor powers of repair, and a waddling gait, to wide separation of the pubes. 3. Tendency to

* For full information on all these matters Mr. J. Wood's articles (*Dict. of Surg.*, vol. i. p. 425, and *Méd.-Chir. Trans.*, vol. iii. p. 85) should be consulted.

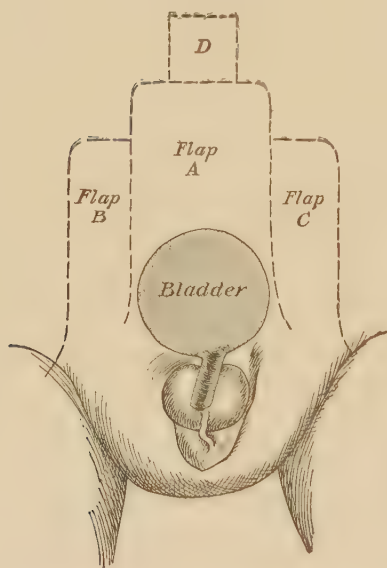
cough. This increases the protrusion. 4. Presence of large herniæ. 5. Secondary dilatation of the ureters and pelvis of the kidneys, with degeneration of viscera. Mr. Wood (*loc. supra cit.*) shows that sometimes the above complication may be recognised by the presence of more albuminuria than is accounted for by the amount of cystitis. In other cases no such signs are present. Out of 40 cases a fatal result, chiefly from this cause and undetected, followed in four. 6. Obstinate eczematous rawness. 7. Small size of the scrotum. This is rare.

Preparatory Treatment.—If the patient has passed puberty, and the hair is at all abundant, depilation should be practised, and nitric acid applied at intervals to the groups of hair-follicles.

It may be well also to try and diminish the size of the ectopia by the means adopted by the late Mr. Greig Smith, who, for some weeks previous to operation, kept the patient on his back, and the exposed mucous membrane shielded with green "protective" coated with dextrine, covering this over with boracic lint, and by this means, in one case, the mucous membrane not only became less angry, but its upper half, almost as low as the ureters, became covered with epidermis almost as white as the surrounding skin. In another case, also successfully operated on, no preliminary treatment was of any avail in diminishing the size of the ectopia.

Operation.—An anæsthetic having been given, a median flap* is raised from the abdominal wall above the exposed bladder. Its shape resembles that of the wooden portion of a fire bellows, its length is rather greater than the distance between the root of the penis and the upper margin of the exposed bladder, while its root must be sufficiently broad to ensure a sufficient blood-supply. In raising it, care must be taken not to cut it too thin, and, at the same time, not to go too deeply with the point of the knife, as the tissues here

FIG. 268.



Wood's operation for ectopia vesicæ (Binnie). Flap A is turned down to form the anterior wall of the bladder, and D may be added to cover the urethra. Flaps B and C are displaced inwards to cover the raw surface of flap A.

bladder. Its shape resembles that of the wooden portion of a fire bellows, its length is rather greater than the distance between the root of the penis and the upper margin of the exposed bladder, while its root must be sufficiently broad to ensure a sufficient blood-supply. In raising it, care must be taken not to cut it too thin, and, at the same time, not to go too deeply with the point of the knife, as the tissues here

* The shape and arrangement of the flaps are excellently shown in pl. ii., Figs. 1 and 2, accompanying Mr. Wood's paper (*Med.-Chir. Trans.*, vol. lii.). Some illustrations of other flaps in a paper by Mr. Mayo Robson (*Brit. Med. Journ.*, 1885, vol. i. p. 222) will also be found useful. And I would direct my readers' attention to a paper by the late Mr. W. Anderson (*Clin. Soc. Trans.*, vol. xxv. p. 78), which contains, as might be expected, some very helpful drawings.

are extremely thin, and the flat, tense, expanded linea alba beneath is often very thin, and thus the peritonæal sac may easily be opened.

The two groin flaps are next made, of rounded oval shape, with broad pedicles, the outer boundary of which is sufficiently carried out on to the thigh, and then on to the root of the scrotum, to ensure its containing the superficial epigastric and the external pudic arteries. The inner margins of these flaps join those for the central flap at about its centre, and are then continued down along the side of the urethral groove for about half its length.

While these flaps must be cut as thick as possible, care must be taken to avoid any subsequent hernia, and they must be sufficiently detached to meet for their whole length, without tension, in the middle line. In raising them they must be handled as carefully as possible, whether with fingers or with bluntly serrated forceps, so as in no way to impair their vitality. All bleeding having been stopped, the flaps washed with boracic acid lotion, and their surfaces allowed to become glazed, the umbilical flap is first taken and folded down, with its skin surface towards the bladder, evenly and without tension. It is then stitched to the cut edge at the root of the penis.

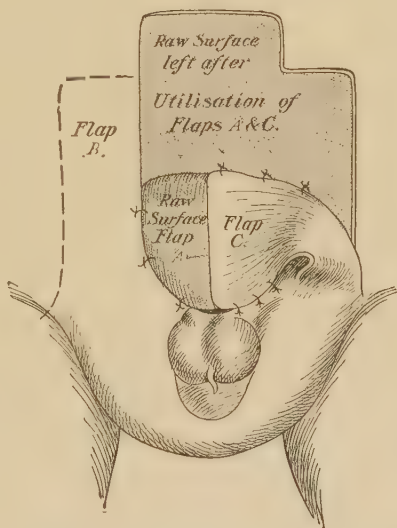
The groin flaps are then drawn inwards, placed with their raw surfaces upon the raw surface of the umbilical flap, and carefully stitched together. The sutures should be many and mixed, of wire, carbolised silk, fishing-gut, and horsehair. Wire has the advantage of being non-irritating and of keeping sweet in a wound which cannot be kept aseptic. The sutures should be left in for a fortnight, and in the case of children it may be well to give an anæsthetic to take them out.

The raw surface from which the central flap was taken is then closed, as far as possible, with long hare-lip pins and twisted sutures. The rest of this wound may be closed, now or later on, by Thiersch's method of skin grafting (Vol. I. p. 188).

The parts are then painted with collodion and iodoform, sal-alembroth gauze applied, and the buttocks and hips smeared with eucalyptus and vaseline. If any redness appear, wet boracic acid lint dressings should be made use of.

(1 b) **Trendelenburg's Operation.**—Prof. Trendelenburg (*Centr. f. Chir.*, No. 49, December, 1885) published a case of extroversion of the bladder in which immediate union of the lateral margins was

FIG. 269.



Wood's operation for ectopia vesicæ (Binnie). The raw surface is lessened by approximation of the edges, and covered with skin-grafts.

obtained by previous division of the sacro-iliac synchondroses. By entirely freeing the joints and breaking their sides free this surgeon has gained an approximation between the anterior superior spines of two inches in a child of two and a half. This approximation is of course only rendered possible by the fact that the symphysis pubis is deficient in these cases. When the bones are thus approximated the lateral margins of the defect are pared, and brought together with sutures. This, when successful, effects a great saving of time, and secures that the cavity of the bladder shall consist, save for a narrow line of scar in front, of vesical mucous membrane and not of scar tissue. As a result the formation of phosphatic deposit is greatly diminished. A very interesting account of this operation has been given by Mr. Makins, with a successful case (*Trans. Med.-Chir. Soc.*, vol. lxxi. p. 191). To be successful the division of the synchondroses should be performed early, *e.g.*, before the child is eight.

Prof. Trendelenburg has recently read a paper before the American Surgical Association, giving his present views and the instructive results of his mature experience (*Ann. of Surg.*, 1906, vol. xliii. p. 281). He maintains that the bilateral separation of the sacro-iliac joints in children before the seventh or eighth year is not the serious procedure that some consider it to be, and that it is very effectual in relieving lateral tension. He believes that transplantation of the trigone into the bowel will be again abandoned on account of the risk of pyelonephrosis, and the inconvenience of micturition through the anus, especially in a male.

By careful paring and re-formation of the neck of the bladder and urethra, he maintains that it is possible in at least some cases to obtain more or less perfect sphincteric control of the bladder, or failing this, to provide artificial control.

Of the cases operated upon by Trendelenburg years ago for defects extending from the umbilicus to the glans penis, three are alive and without any fistulous openings, but with a complete bladder and urethra. "The bladder when distended consists of a spherical cavity lined with mucous membrane over its greater extent. The passage of small concretions is occasionally observed by these patients, but the tendency to calculus formation is by no means as marked as in certain cases operated upon by Thiersch (flap method) which I have had occasion to examine.

"These patients partly suffered to such an extent from the production of calculi, incrustations, and ulcerations in the irregular crypts of the bladder, that they demanded operation by some other method for the relief of their condition.

"Retention of urine is not complete in any of my three cases. These young men, therefore, wear a contrivance supplied with a small spring which compresses the urethra at the root of the penis, either from the front or the back. The patients are now students at college; they are not greatly inconvenienced by the apparatus, and by proper care and attention they avoid the production of any odour which would serve to attract attention to their condition. If the spring is raised the urine issues forth in a stream. On lying down it collects in the bladder without leakage. One of the men remains dry throughout the night, he may be awakened once or twice by the desire to urinate, and even

when he gets up he can voluntarily retain the urine for several minutes, and then pass it naturally in a stream. A fourth patient, a boy of five, could also, when he tried, retain his urine for several hours when standing or walking, but later on at the time of his leaving the clinic the ability was lost.

"Both of the two cases last mentioned demonstrate that physiological factors necessary for both retention and voluntary micturition are present, and that they are merely prevented from functioning in a normal manner by certain mechanical conditions. The reason for the failure may be accounted for by the fact that the two sections of the pelvis, which have been separated at the sacro-iliac synchondrosis, have a tendency to gradually resume their former positions; therefore the neck of the bladder and the prostatic portions of the urethra, which are closely connected with the pubic bones, are pulled upon to such an extent that the muscular ring can no longer be brought into play.

"I have made several attempts to overcome this difficulty by mobilising the pubic bones, with the help of the chisel, or by dissecting widely the attachments of the urethra and the neck of the bladder to the latter. In no instance of complete ectopia have I been favoured, however, with a permanent result. Such a procedure, moreover, is apt to lead to the production of a dense scar along the vesical neck, which in the event of a later secondary operation will be found a source of as great annoyance as the cicatrices in a hare-lip which has failed to heal by primary union."

Cases of partial ectopia or of epispadias and incontinence are more favourable, and Prof. Trendelenburg has been able to obtain excellent results in a few of these by paring freely enough and carefully suturing the vivified edges of the urethral groove or deficiency in the lower part of the bladder. The margins of the vesical part of the wound are inverted. During these procedures the pubic bones are strongly retracted, and the pelvis is elevated.

Only a fine drainage tube is left in the newly completed urethra, for a catheter might exert too much pressure on the sutured tissues. The bladder is drained through a special opening until healing has occurred.

In the case of a female child with epispadias and incontinence, Prof. Trendelenburg was able to suture the pubic bones together after separating the right sacro-iliac joint and suturing the urethra and neck of the bladder. Success did not attend the operation, which was therefore repeated. This time the result was good, and it remained perfectly satisfactory six years later.

It is rarely possible to complete the pubic arch in cases of extensive ectopia, and "wiring of the bones, particularly in boys, cannot be advantageously employed, because the wire comes in conflict with both the bladder and the penis. In younger children, moreover, the wire is very apt to cut its way through the tissues" (Trendelenburg, *loc. cit.*).

Trendelenburg believes that this approximation can be best accomplished by the gradual effect of pressure by means of an elastic pelvic girdle worn day and night. This method is most likely to be successful when adopted after separation of the bones at both sacro-iliac joints. When the pubic gap has been greatly diminished, a

plastic operation can be undertaken for reconstructing a bladder and urethra.

It may be safely concluded, I think, that the results of Prof. Trendelenburg are as good as any that can be obtained by any plastic method, even with the advantage of unusual skill and long experience, but the functional results are not encouraging except in cases of partial ectopia, and epispadias with incontinence.

König has lessened lateral tension by dividing the rami of the pubis and ischium, and Schlange has adopted a similar method.

Segond has liberated the upper part of the bladder without opening the peritonæum, and brought it downwards as a flap, and sewn it to the refreshed lateral margins of the urethral gutter and sides of the trigone. He then made a transverse incision through the base of the pendulous prepuce and brought the penis through this aperture. The prepuce was then used to cover the raw surface of the flap on the dorsum of the penis. After this operation the urine can be more easily collected and conducted into a suitable urinal.

After-treatment.—The patient must be partly sitting, the shoulders being well propped up and the knees flexed; a bandage passed from the knees around the shoulders will facilitate this. Any sudden straightening of himself by the patient is fatal to a good result. For the first few days small opiates or injections of morphia will be required.

(2) **Sonnenburg's Operation** consists in transplantation of the ureteral ends into the upper end of the gutter which represents the urethra. The rest of the vesical mucosa is resected without opening the peritonæum. A suitable urinal can be worn after this procedure with comparative ease. The gap in the parietes can be closed either completely or in part by the appropriate use of flaps. It is less dangerous, but also far less satisfactory, than Maydl's method.

(3a) **Anastomosis of the Bladder and Rectum.**—Frank (*Ann. of Surg.* vol. xxxvii. p. 291) makes an incision in the posterior wall of the bladder and anastomoses the bladder and rectum by means of his absorbable coupler. He then frees the edges of the bladder, turns them in, and sutures them together. Dr. Halsted frees and turns in the thick mucous membrane only, leaving the fascia behind, so that the peritonæum may not be opened. He uses Murphy's button for making the anastomosis. Direct suture is preferable.

The abdominal wall is then closed as far as possible. Senn (*loc. cit.*) performed the operation in two stages, first making a longitudinal incision in the bladder, through which he drew a piece of rectum or lower part of the sigmoid, and fixed it to the bladder wall. Three days later the bowel was opened, and the edges of the mucosa were joined to the mucous membrane of the bladder.

A plastic operation to close the bladder was undertaken later, but this did not succeed at the first attempt.

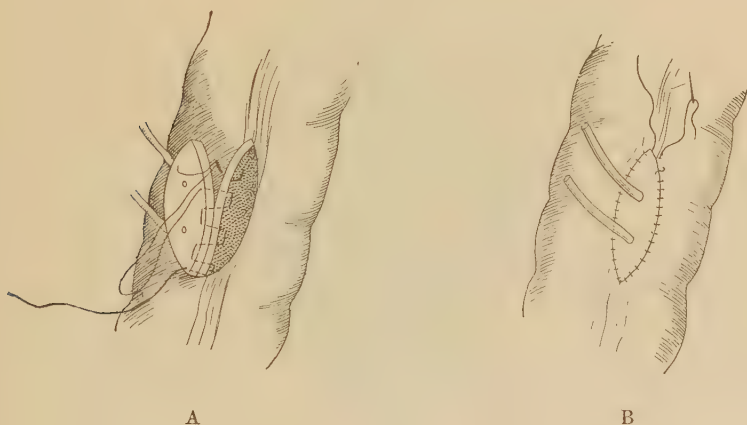
This plan is not so satisfactory as direct implantation of the trigone into the bowel, for the attempt to preserve and close the ectopic bladder is attended with more frequent failure or formation of fistulæ, which may discharge either urine alone or fæces also. It is probable also that calculi will form in the vesical diverticulum which communicates with the rectum, unless the fistula is a wide one.

Further it is not necessary to save the whole of the bladder, for the rectum soon affords plenty of room for the urine.

(3b) **Maydl's Operation.** Transplantation of the Trigone into the Sigmoid Colon.—An area of the bladder, including the trigone, is then carefully dissected up and separated from the rest of the bladder and commencement of the urethra. The excess of the vesical mucosa is then excised and the field of operation thoroughly cleansed before the abdomen is opened in the middle line.

A loop of sigmoid is now drawn through the wound, and the abdominal cavity protected by gauze packing. A longitudinal incision of the required length is next made in the right side of the exposed loop

FIG. 270.



Maydl's operation. (Binnie.)

A, The portion of bladder is sutured into the sigmoid colon; the deep suture penetrates all the coats. B, The deep suture is reinforced by a continuous Lembert suture.

of sigmoid, escape of contents being prevented, if necessary, by the application of clamps. The trigone is now rotated through about ninety degrees, so that the ureters now lie above one another instead of side by side, and is attached to the margins of the opening in the sigmoid by means of sutures.

Two sutures are used, a continuous deep one of catgut piercing all the coats in order to secure a firm hold until union occurs, and a superficial continuous Lembert or Cushing suture of fine silk (*vide* Fig. 270 A and B).

The sigmoid is cleansed and dropped back into the abdomen. A tampon of iodoform gauze is then passed down to the site of the anastomosis to provide against possible leakage, and the rest of the wound closed.

Maydl considers the sigmoid to be preferable to the rectum for implanting the trigone, because he believes the risk of ascending infection to be less on account of the comparative emptiness of the sigmoid.

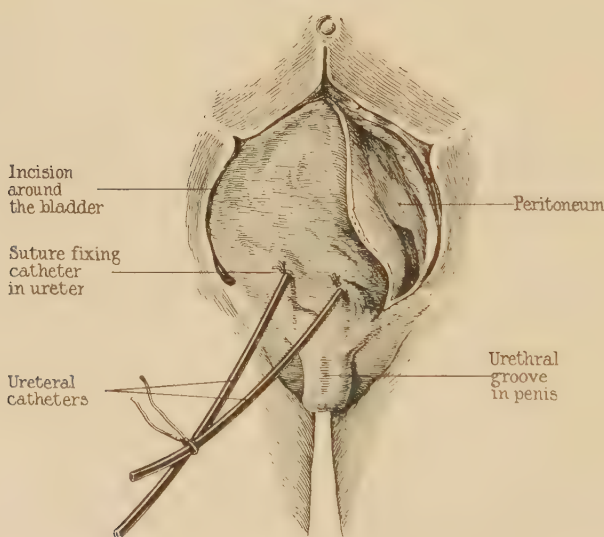
Gersuny's modification of Maydl's method adds to the severity of the

operation without conferring any real advantage. He divides the bowel across at the junction of the sigmoid and the rectum, implants the trigone into the upper end of the rectum, and the sigmoid into the wall of the rectum lower down.

Dr. Peters, of Montreal, successfully transplanted the ureters into the rectum extraperitonæally. The patient was six years of age at the time when Dr. Peters recorded the case. The urine could be retained in the rectum for three hours during the day and for eight hours during the night.

(3c) **Transplantation of the Whole of the Ectopic Bladder into the Wall of the Rectum.**—Mr. Moynihan (*Ann. of Surg.*, 1906,

FIG. 271.



Moynihan's method of transplanting the ectopic bladder into the anterior wall of the rectum (redrawn from the *Ann. of Surg.*). The bladder is carefully liberated without opening the peritonæum. The ureteral catheters are fixed in position by sutures.

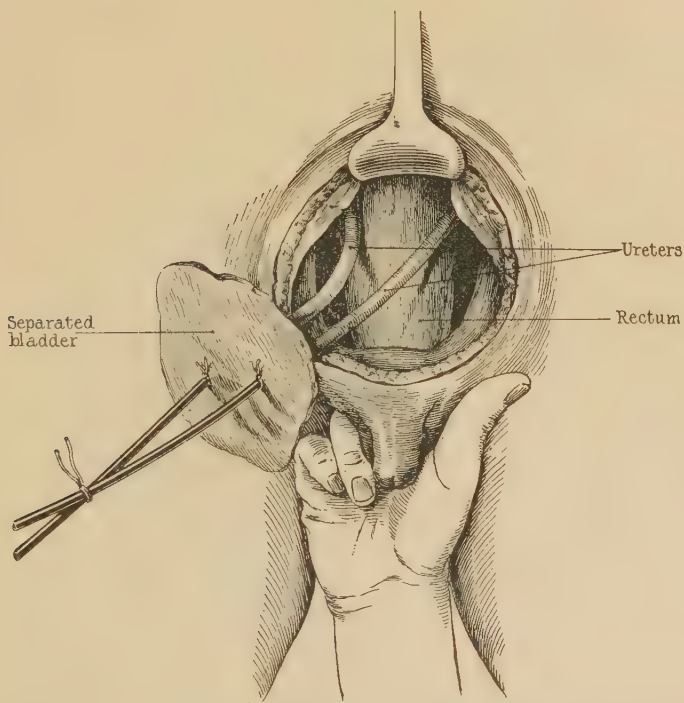
vol. xliii. p. 237) successfully transplanted nearly the whole of the ectopic bladder into the rectum in a young man aged 19. "A plastic operation had been performed fifteen years earlier, but the lower part of the vesical mucosa was still exposed, and the urine was discharged upon the exposed surface. It was there caught in the usual rubber receptacle, of pestilent odour, and drained downwards to the leg. The patient, with increasing years, had become more painfully aware of the misery of his condition, and begged to have something, anything, done to relieve him of his terrible affliction."

It occurred to Mr. Moynihan that "if a large area of the bladder could be grafted, so to speak, into the rectum, the capacity of the bowel would be increased, and a veritable cloaca formed. My only doubt was that the vascular supply furnished along the ureters might be insufficient for a large area of the bladder. But in the operation I

now describe I found that when the edges of the bladder were trimmed with scissors, a free oozing of blood occurred from the cut surface. I therefore was able to transplant the entire bladder."

Operation.—"The ureters were first catheterised. Owing to the previous constant friction against the exposed bladder mucosa, which pouted exuberantly, this little manœuvre was by no means easy. A catheter was passed for four inches into each ureter, and was fixed there by a single stitch, which caught up the tube on one side and the bladder on the other.

FIG. 272.



Moynihan's method of transplanting the ectopic bladder into the anterior wall of the rectum (redrawn from the *Ann. of Surg.*). The ureters are not separated nearly so freely as shown in the figure.

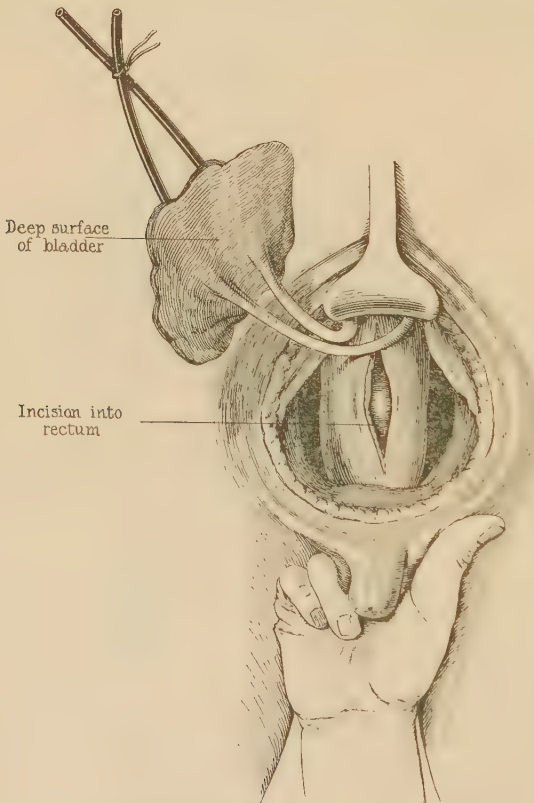
A vertical median incision was then made from the exposed bladder mucosa towards the umbilicus, the flaps which had been turned over to the middle line in the previous operations being completely cut through. On turning aside the flaps thus made the upper previously covered mucous surface of the bladder was exposed; it was found to be smooth, thin, and entirely different in character and appearance from that of the lower exposed part. An incision all round the margin of the mucous membrane of the bladder was now made between the mucosa and the skin, and the incision was deepened by degrees until a good thickness of the bladder could be raised up.

The dissection from the margin of the bladder towards the ureters was continued round the whole circumference little by little. This was

difficult in part owing to the fact that there was much scar tissue left from the former operations, in part because the great vascularity demanded frequent cessation to restrain hæmorrhage by pressure. The separation above the pubes was most difficult, and here the prostate had to be separated with great care.

The purpose of this process of separation was to isolate the whole of the bladder, leaving only as its pedicle, so to speak, the two ureters. As much tissue was left round each ureter as possible, so as to avoid

FIG. 273.



Moynihan's method of transplanting the ectopic bladder into the anterior wall of the rectum (redrawn from the *Ann. of Surg.*).

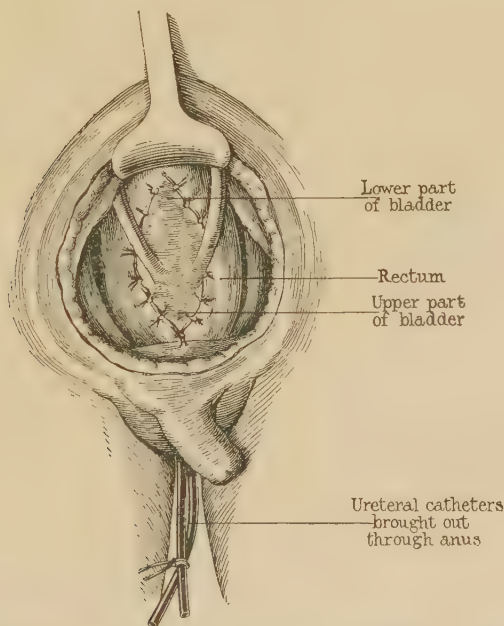
the possibility of damage either to the ureter itself or to its vessels. In the annexed diagram (Fig. 272) the ureters are shown clearly defined. This was not their condition during the operation. The figure is drawn only for the purpose of making the details of the operation clear. As soon as the bladder was well isolated, it was drawn forwards towards the umbilicus and there held by an assistant. In the bottom of the wound the rectum was now seen, and above the peritonæal reflection on to it. The serous covering was then stripped upwards from the front of the rectum until four or five inches of the bowel lay exposed at the bottom of the wound. In stripping the peritonæum up a small rent

was made into it, which was closed at once by a continuous catgut suture.

The finger of an assistant was now passed into the rectum to make it prominent, and along the anterior surface of the bowel an incision about three and a half inches in length was made (Fig. 273).

The upper and lower ends of this incision and the mid points of the sides were held with small vulsella, until a large opening was made. Into this opening the bladder was placed, being turned upside down, so that its former anterior surface became posterior, and its former lower end became the upper.

FIG. 274.



Moynihan's method of transplanting the ectopic bladder into the anterior wall of the rectum (redrawn from the *Ann. of Surg.*). The bladder has been rotated so that its upper end is now lowest and fixed to the lower part of the wound in the rectum. The ureteral catheters are brought out through the anus.

The ureters, instead of passing forward to the bladder, passed backward, and the catheters passed into the rectum and out at the anus. The edge of the bladder and the cut edges of the rectum were now sutured together by two stitches that were continuous, one taking the right side and the other the left (Fig. 274). The sutures were passed after the manner of Lembert, so that no mucous membrane was included in them. A few additional interrupted sutures were necessary here and there. When the sutures seemed to be securely uniting the bladder and the rectum, the wound was dried, and the skin edges along the original median incision were drawn together. At the upper end the edges came well into apposition, but about an inch at the lower part had to be left open. The catheter which had been introduced into the ureters now passed out of the anus; the sphincter had previously been

stretched. The operation lasted an hour and a half. The after-progress of the case was satisfactory. The catheters remained in the ureters for four days, the urine being collected into a bottle. After their removal the urine passed into the rectum, and dribbled out at the anus, which, owing to the stretching of the sphincter, as yet exerted no control. On the seventh day a little urine began to leak by the abdominal wound, and this continued for a week. On the fifteenth day an anæsthetic was again administered, and the leaking point in the former line of suture discovered and made good. From this day the wound remained absolutely dry, all urine escaped by the rectum, and control gradually returned, until at the end of the month it was perfect. Urine was then passed by the rectum about every two hours. The interval between the acts of emptying the rectum has gradually increased until now (November, 1905) the shortest period is three hours, and the longest five hours. The urine is quite sweet and is normal on examination.

When the rectum is now examined, the line of junction between the mucous membrane of what was the bladder and the mucous membrane of the rectum cannot be distinguished. All feels smooth and even and continuous. There is a fairly capacious cloaca."

In February, 1907, Mr. Moynihan very kindly sent me a letter which he had just received from the medical attendant, Dr. Empey. The following is an extract from the letter:—"He is following the occupation of weaving, and presents the appearance of possessing excellent health. There is slight suppuration of the wound in front still going on, but nothing of importance. He requires to empty the rectum four or five times in the twenty-four hours. The longest interval, I am given to understand, is from three to four hours during the day. He very occasionally wets the bed a little."

HYPOSPADIAS.

Varieties.—These are three, viz.: 1. Glandular. The opening is here merely farther back than usual; the frænum is absent, the glans broad, flattened, somewhat recurved, and the prepuce, often hood-like, always in a condition of partial paraphimosis. 2. Penile. Here the urethra is especially liable to open at one of the three following sites: (a) just behind the glans; (b) at the middle of the penis; (c) at the junction of the penis and scrotum. 3. Scrotal.* Here the cleft on which the urethra opens may be either at the junction of the penis and scrotum, or involve the scrotum and perinæum, the former being called peno-scrotal and the latter perinæo-scrotal.

When an operation is under consideration with a view of rendering micturition and coitus normal, the surgeon must take into due consideration—(a) the degree of the deformity; (β) whether the penis is fairly developed; (γ) whether it is much tied down; (δ) whether the testicles are present and descended; (ε) how far the patient's condition is made miserable by rawness and eczema due to impeded micturition, and by impeded coitus, and how far there are reasonable hopes of remedying these. Four methods of operating will be described.

* The above is sometimes divided into two, scrotal and perinæo-scrotal.

1. **Duplay's Operation.**—The operation is divided into the following three stages, which require, in order to be successful, much time and patience on the part of both surgeon and patient :

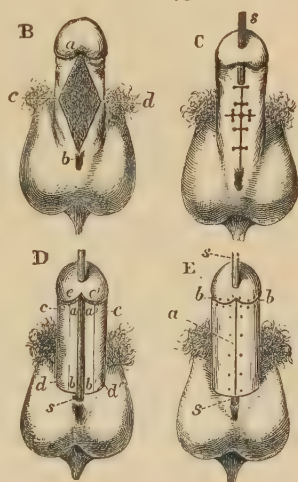
i. *Straightening the penis and formation of a meatus* ; ii. *Formation of a canal from the meatus to the hypospadiac opening* ; iii. *Junction of the old and new canal.*

i. *Straightening of the Penis.*—In the penile, peno-, and perinæo-scrotal varieties, the penis, often short, is recurved,* especially during erection, by a band consisting partly of a muco-cutaneous ridge, corresponding to the absent urethra, and reaching from the hypospadiac orifice to the glans. M. Bouisson seems to have first pointed out the importance of dividing this, which he did subcutaneously. M. Duplay recommends division by an open wound, carrying the incision as deeply as needful, and states that the corpora cavernosa may be incised to a very considerable depth, if needful to secure this end. M. Duplay's incision leaves a lozenge-shaped wound, which he unites by sutures (Fig. 275, B and C).

At the same time the above-named surgeon forms a meatus. This is done by paring the two lips of the depression which represents the meatus, and uniting these over a bit of catheter. If the depression be very shallow, an incision upward into the glans-tissue, or two lateral ones, may be needed before it is possible to insert a catheter, and to apply sutures round it.

ii. *Formation of a New Urethra.*†—The penis being held up, two incisions are made a little outside the lateral margins of the mucous surface corresponding to the deficient urethra, and reaching from the glans to the hypospadiac orifice. By making two transverse incisions at either end, two narrow quadrilateral flaps, *a, b, a', b'* (Fig. 275, D), are dissected up towards the middle line until, with their mucous surfaces turned inwards and their raw surfaces outwards, they meet without tension over, and thus shut in a catheter passed from the previously restored meatus to the hypospadiac orifice. A bougie or rod can be used instead, and a catheter passed into the bladder through the misplaced urethral orifice, so that urine is less likely to leak by the side of the catheter and infect the sutures. These flaps are now united with sutures, partly of fine chromic gut and partly of fine carbolised silk, cut quite short. From the sides of the penis two similar flaps, *c, d, c', d'* (Fig. 275, D), are dissected up from within outwards, till they can be sufficiently drawn inwards without tension to cover over the raw surfaces of the internal flaps. They are then

FIG. 275.



(Bryant.)

* This recurving is also in part due to thickening and shortening of the capsule of the corpora cavernosa, and even of the septum.

† Several months, at least five or six, must elapse before the surgeon is certain that no recurving will occur. This disappears very gradually.

carefully united in the middle line (Fig. 275, E). I much prefer horsehair and fishing-gut sutures here, well soaked previously in warm carbolic acid.

In operating upon boys—and I consider nine to fifteen as the best age—I prefer, in penile hypospadias, to make the new glans and restore the floor of the urethra at one sitting. Any points where union fails can be closed later. The chief trouble is the retention of the catheter sufficiently long. I have usually found that after the third day the delicate

FIG. 276.

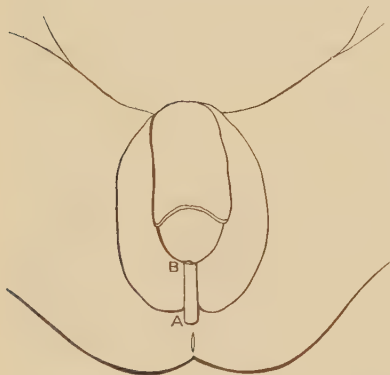
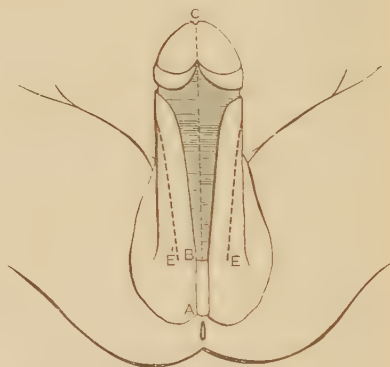


FIG. 277.



mucous membrane of a child's bladder resents the catheter—a very little mucus quickly plugs these small instruments—and a nurse must be instructed to pass a small india-rubber catheter every two or three hours. In the intervals a short bit of bougie is kept in the new urethra and glans to maintain the patency of the canal. Iodoform and collodion with a dry dressing of iodoform gauze are the best dressing.

Mr. Makins describes (*Lancet*, 1894, vol. ii. p. 1141) a method of restoring the urethra in hypospadias, in which Thiersch's operation is ingeniously modified. By the use of three tiers of suture not only is the new urethra built up firmly, but the prepuce is restored as well.

FIG. 278.



iii. *Joining the Old and New Urethra.*—As soon as the new urethra is thoroughly established, quite closed, and shows no sign of contraction, this last stage may be undertaken. The edges of the posterior end of the new urethra and those of the remaining orifice having been freely vivified, and a catheter passed from the meatus into the bladder,

the opening is closed over it by sutures as in stage ii. A catheter—one of Jaques' pattern is least painful—should be kept in the bladder if possible till all is water-tight.

2. *Russell's Method* (*Brit. Med. Journ.*, Nov. 17, 1900).—Mr. Hamilton Russell, of Melbourne, describes the following method which he has devised and used successfully on a boy, aged 9, the subject of hypospadias of the perinæo-scrotal type. In view of the excellence of the result in the above case, the method is well worth a trial. The

operation is performed in two stages, and is described by Mr. Russell as follows :—

First Operation.

A thread is passed through the glans penis to serve as a tenaculum and the glans drawn upwards.

Step I.—An incision through the frænum which binds down the glans. This incision may be carried at once right down the penis, so as to divide the prepuce on the dorsum by a circular sweep not too close to the corona. The tip of the left index finger is inserted into the gaping wound in the concavity of the penis, and the structures which bind it down are felt and divided by successive cuts with scissors. In this way will be divided a number of dense fibrous bands and portions of the sheaths of the corpora cavernosa, and the scissors must be freely used until the penis is quite released and can be drawn out straight. There will now be a great length of raw surface exposed between the extremity of the perinæal urethra and the glans, and the median sulcus

FIG. 279.

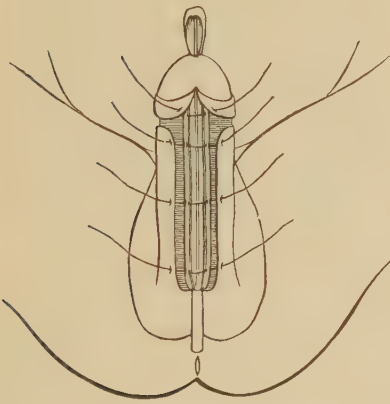
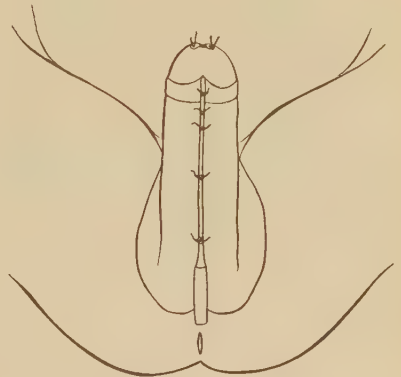


FIG. 280.



between the corpora cavernosa may be deepened by a little careful dissection, and removal of the remains of the longitudinal fibrous bands that have been divided (Fig. 277; the shaded portion shows the shape of the raw surface exposed.)

Step II.—Perforation of the glans for the reception of the glandular urethra :—A tenotomy knife, with the edge turned towards the dorsum of the organ, is thrust through the substance of the glans, close to the under-surface; the structure is incised freely towards the dorsum, leaving a capacious channel through its substance.

Step III.—The incision indicated by the dotted lines $E'E'$ (Figs. 277 and 278), starting near to the extremity of the perinæal urethra, about one-third of an inch or less from the cut margin of the skin, the incision is carried, always parallel to the cut margin, over the dorsum of the penis to the corresponding point on the opposite side. By this incision a strip of prepuce will be marked out which surrounds the penis in a manner closely resembling a clergyman's stole (Figs. 277 and 278). This loop of skin is then detached from its connections everywhere except at its extremities, and slipped over the end of the penis, exactly

as a clergyman removes his stole. The loop of prepuce is then simply manipulated so that the cutaneous surfaces are placed in apposition, the raw surfaces being turned outwards; a sinus-forceps is passed through the channel in the glans, the loop seized and pulled through (Fig. 279). The redundant portion of the loop is then cut off, and the two lateral portions of the new urethra fixed in position by one or two stitches at the meatus (Fig. 280).

Step IV.—Adjustment and suturing of the preputial flaps. On the dorsum of the penis this is just a simple procedure, as in circumcision. On the under-surface of the organ, where the prepuce is made to cover over the two edges of the new urethra, these edges should be included in the sutures, so that in each suture four cutaneous edges are brought together, namely, two of prepuce and two of new urethra (Fig. 280). Before finally tying these sutures inspection should be made of the spot where the perinæal urethra becomes continuous with the new penile urethra; a nipple-like projection of skin is likely to be present at this place, and should be snipped off with scissors.

The posterior (or dorsal) edges of the new urethra will be adjusted in the mesial sulcus between the corpora cavernosa, and will not require any suturing. The sutures having been tied, a narrow bandage of iodoform gauze may be then wound round the organ, and left undisturbed for several days. The result, when completed, is portrayed in Fig. 280. It is scarcely necessary to remark that no rod of any kind should be inserted in the new urethra. Should there be any defect in the success of this operation, it would be wise to remedy it before finally proceeding to the closure of the perinæal urethra.

Second Operation: Supra-pubic Cystotomy and Closure of the Perinæal Urethra.

This last is really by far the most difficult part of the whole procedure, and demands care, skill, and experience in this kind of plastic work. To the operator who brings these qualities to the task, however, success will come easily. There is one point of paramount importance to the success of this part of the operation. It is necessary to define accurately the ridge where the urethral mucous membrane merges into the skin of the perinæum; the separation between the two must be made exactly at this ridge, and it is best accomplished by taking a delicate pair of scissors and cutting off the crest of the ridge all the way round. It will be necessary to incise the skin of the perinæum posteriorly to a small extent, in order to expose the hinder margin of the urethral orifice. The reason for such great precision on this point is, that if any of the perinæal skin be left attached to the urethral margin at any spot, the attempt at closure will certainly fail at this point; while if, on the other hand, the incision is so made as to leave any portion of the urethral wall attached to the perinæal skin, that will be a sacrifice of urethral wall which can by no means be afforded. The edges of the urethra should now fall naturally together when the thighs are approximated, and they need not be sutured. The perinæal skin should be undercut slightly and approximated by a few sutures, and the wound dressed with a layer of gauze and collodion. Should healing have taken place throughout, the bladder drain may be removed in a fortnight.

3. **Beck's Operation.**—This is suitable for cases in which the misplaced urethral orifice is not far behind the glans.

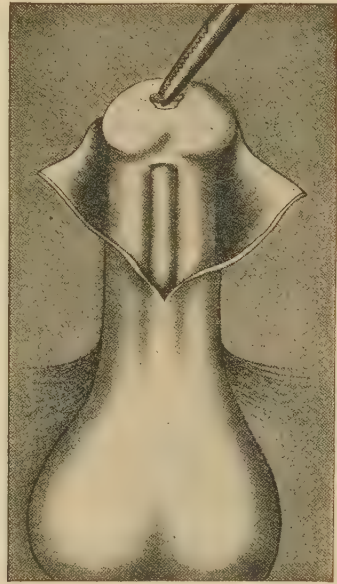
The distal part of the urethra is isolated and mobilised as shown in Fig. 281, so that it can be brought forwards and sutured either to the urethral groove on the under-surface of the glans, or the anterior end

FIG. 281.



Beck's operation. (Binnie.)

FIG. 282.

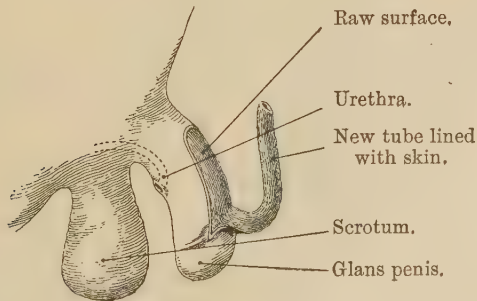


Beck's operation. (Binnie.)

of a perforation made in the latter (Ochsner (*vide* Fig. 282). The skin is then sutured over the urethra.

(4) **Van Hook and Mayo's Operation.**—Dr. C. H. Mayo (*Journ. Amer. Med. Assoc.*, April, 1901) pulls the prepuce well forward, and fashions

FIG. 283.

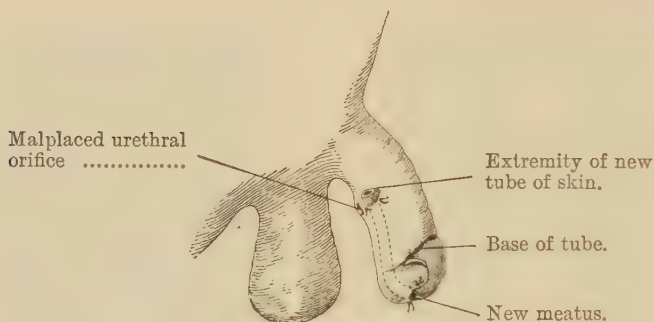


(After C. H. Mayo.)

from it and from the dorsum of the penis (if necessary) a flap about one inch wide and two and a half inches long. The flap is left attached at its base near the corona of the glans, and its edges are sewn together, so that a tube lined with skin is formed (*vide*, Fig. 283).

A tunnel is then made with a narrow-bladed knife, which is passed through the glans, above the urethral groove, and out near the misplaced urethral orifice near the root of the penis. The new-formed

FIG. 284.

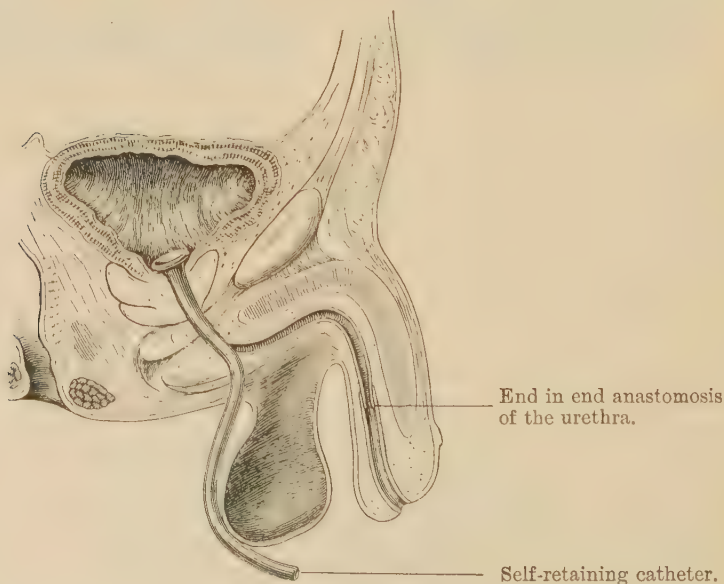


(After C. H. Mayo.)

tube is then drawn through the tunnel and fixed with sutures both at the glans and at its exit (*vide* Fig. 284).

The gap upon the dorsum of the penis is closed.

FIG. 285.



(After C. H. Mayo.)

About ten days later the base of the flap is severed just in front of the glans, and a new meatus is thus formed.

At a second operation the urethra is opened in the perinæum, and a self-retaining female catheter inserted (*vide* Fig. 285) and left in for about a week.

The extremity of the old urethra is mobilised and implanted into the open end of the new part, and the skin wound closed. As some urine often leaks into the urethra in front of the catheter, it is well to pass several strands of silkworm gut or horsehair through the urethra and out alongside the catheter in the perinæal opening. (Fig. 285.)

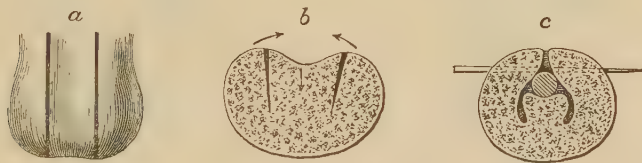
EPISPADIAS.

I shall not give any really full account of the different attempts to cure this rare condition. For some points of practical importance I would refer my readers to the remarks on hypospadias (p. 716).

Any attempt at curing epispadias should be divided into three stages, thus :—

i. *Straightening the Penis.*—While the penis is short, recurved, so as to lie in contact with the abdominal wall, it is no use trying to complete the defective urethra. Attempts should be made to straighten the penis by dividing it subcutaneously close to the pubes, each corpus cavernosum being cut separately. In the only case in which I practised

FIG. 286.



Making a canal in the meatus. (After Esmarch and Kowalzig.)

this, in a patient aged 17 the hæmorrhage was easily controlled by dry gauze and light pressure, but very sharp tenotomes must be employed, as the erectile tissue offers much less resistance than a tendon. Each corpus cavernosum should be divided completely, and as cleanly as possible. The penis must, for some time, be kept fastened down. Improvement in its position takes place gradually, together with increase in its length, this being eventually more marked the earlier the operation is performed.

ii. *Making a Canal in the Glans Penis.*—Two deep incisions are made parallel to the urethral groove; a glass rod is then laid in this groove; the lateral flaps are brought up and sutured over the rod (vide Fig. 286).

iii. *Completion of the Deficient Urethra from the Glans to the Epispadiac Opening.*—The simplest way of effecting this is by the method of Thiersch and Duplay, much as in hypospadias, to the account of which I would refer my readers. Two narrow quadrilateral flaps, extending from the meatus to the epispadiac orifice, are marked out and dissected up from without inwards on either side of the open urethra, both being left attached in the middle line. These, turned with their mucocutaneous surface inwards over a small Jaques catheter, to form the new urethra, and their raw surfaces outwards, are united in the middle line with numerous points of sutures cut short and buried (p. 287). Thin flaps dissected up from within outwards from off the dorsum and sides of the penis are then drawn

inwards, raw surfaces being thus opposed to raw surfaces, and kept *in situ* by numerous points of suture. The continuity of the glandular and penile urethra is established at this operation.

iv. *Junction of the Old and New Canal by Closure of the Epispadiac Opening.*—This is effected by freely refreshing the surrounding parts and suturing them carefully, or a flap with its raw surface may

FIG. 287.

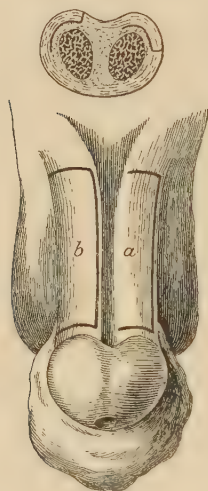
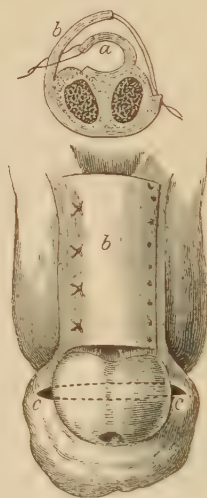


FIG. 288.



Thiersch's operation for epispadias. (After Esmarch and Kowalzig.)

be used (Cheyne). Before the union is complete several operations may be required both for this condition and hypospadias.

A modification of Russell's operation for hypospadias might also be used here, and the method of Van Hook and Mayo is also equally applicable (p. 721).

CIRCUMCISION (Figs. 289, 290, 291.)

Trivial as this operation seems, it is so important, especially in adults, to secure speedy healing, that it will be briefly alluded to here.

Indications.—This operation is still not practised often enough, especially amongst poorer patients, and many practitioners still treat phimosis as a matter of but little importance. Hospital surgeons have, only too often, opportunities of seeing the following results follow from the above course:—(a) Balanitis and adhesions. (b) Paraphimosis, from the forcible retraction of a phimosed prepuce. (c) From the impediment to micturition, urethral and vesical irritation, and even cystitis, may be set up, simulating the symptoms of stone. (d) Hernia and prolapsus recti. (e) The sexual feelings too early induced, and bad habits.* (f) Impediments to intercourse. (g) Intensified gonorrhœa, chancres, &c. (h) Epithelioma.

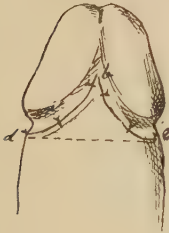
* Prof. Sayre (*Orthopædic Surgery*, p. 14) describes cases in which paralysis of certain groups of muscles, leading to talipes and other deformities, followed on early sexual excitement, due to phimosis. See also the case recorded by Mr. Hilton (*Rest and Pain*, p. 276).

Operation.—This may be performed in many different ways, but the following points must be remembered in every case: (1) To remove enough of the mucous layer of the prepuce. If this be not done, some tension on the glans remains, and this leads, especially in adults, to troublesome erections which interfere very much with the process of healing; later on some degree of phimosis is certain to persist. (2) Not to leave too much tissue about the frænum.

Sir Henry Howse (*Guy's Hosp. Rep.*, 1873, p. 239) has drawn attention to the fact that the cellular tissue at this spot is loose, and that the presence of the frænal artery makes probable the gathering of blood and inflammatory effusion at this spot. In children this is a matter of less importance, but in adults it may lead to the formation of a tediously persistent lump, interfering with the function of the organ.

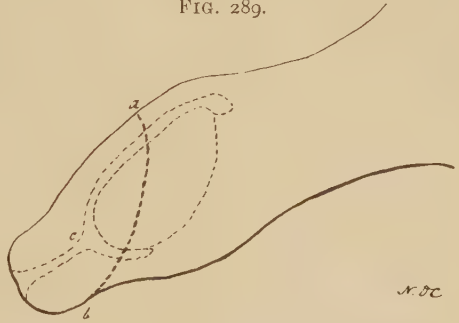
(3) Not to remove too much of the prepuce. Thus it is always well,

FIG. 290.



The pointed process of skin (b) is shown adjusted in the angle left by the remains of the frænum. The dotted line (b, d, e) shows the edge left on the skin and the triangular bare surface which has to heal by granulation unless precautions are taken to preserve the triangular flap of skin as directed above. (Davies-Colley.)

FIG. 289.



a, b, Shows the line of incision by which the prepuce is removed. c, The point of constriction of the mucous membrane which causes the phimosis. The finer dotted line shows the mucous membrane lining the prepuce and covering the glans. (Davies-Colley.)

in adults especially, to leave enough to cover easily the sensitive papillæ with which the corona abounds. Again, in the diminutive penis of infants it is very easy to remove so much as to nearly flay the body of the organ.

The following is a very simple mode of operation: The prepuce having been separated as much as possible from the glans with the finger and thumb, or a stout probe, a pair of dressing-forceps is lightly placed on the penis at a level with the corona; the glans being next allowed to slip back, the forceps are closed, and all the prepuce in front of the instrument is cut off with a sharp scalpel used with a rapid sawing movement. The following directions given by the late Mr. Davies-Colley (*Guy's Hosp. Rep.*, 1892, p. 164) are worth remembering at this early and most important stage of the operation: "The incision should begin upon the dorsum, at a point corresponding to that part of the glans which is half-way between the meatus and corona. The incision should

be made downwards and forwards, so as to leave a sharp point in the middle of the under-surface (Figs. 289, 290). The object of this pointed projection is to fill up subsequently the triangular interval, which is otherwise left when the portion of the mucous membrane of

the prepuce, to which the frænum is attached, is removed. The blades being at once removed, the mucous membrane is then slit up with a director and scissors or a sharp-pointed bistoury,* this incision running up to, but not beyond, the corona. The mucous membrane, if still adherent, must be peeled in two flaps from off the glans, this detachment being best effected by the finger and thumb, or by a stout probe swept round. The cut edges of the prepuce are then rounded off with scissors, which follow the curve of the glans as far as the frænum. Just a frill of mucous membrane, and no more, should be left all the way round the corona (Fig. 291). Enough prepuce should be left to cover over the corona-papillæ, and to admit of easy stitching." All bleeding must be stopped, especially in adults, or extravasation of blood in the loose connective tissue leads to tension, cutting through of sutures, and sloughing. By drawing the skin backwards with the left hand, the bleeding arteries are exposed, and clamped with pressure

FIG. 291.



The penis after the edge of skin has been sutured to the frill of mucous membrane left along the corona. (Davies-Colley.)

forceps, which are either left on for about a minute or twisted. This systematic search for and clamping of the bleeding points saves much possible trouble and annoyance from reactionary hæmorrhage. Chromic gut and horsehair make the best sutures. Very fine needles should be used, and the sutures passed quickly through skin and mucous membrane with a stabbing movement, and without bruising the edges with forceps. In passing the sutures any bleeding points must be transfixed, and the abundant cellular tissue kept in its place with the point of a probe. This

cellular tissue must on no account be cut away, as in it run the vessels to the prepuce. The frænum is now attended to, the prepuce which is still attached here being cut away carefully by V-shaped cuts, pointing forwards, and leaving just enough flaps to carry the sutures, and no more. The frænal artery can usually be secured by transfixing it with one of the sutures; if not, it is readily tied with a fine chromic gut ligature.

I much prefer interrupted sutures of chromic gut for circumcision. A continuous suture often gives good results in healthy subjects, but the former has the great advantage that one or two can be removed, if needed, without interfering with the rest. The majority soften away.

One of the following dressings will be found the best:—A strip of dry aseptic gauze is wrapped round the wound at the operation, for this stops any hæmorrhage well. A pad of antiseptic wool is then placed over the penis and kept in position by the pyjamas, or in a child by the diaper. This protects the sensitive glans and the wounded penis from injury and irritation. The dressing is removed in a warm bath after two days, and then replaced by an aseptic gauze

* It is well at this stage to make tension on the loose prepuce with two pairs of dissecting forceps, and thus secure a clean section.

strip lined with boracic ointment. This is very comfortable, and is easily removed in a warm bath without causing any pain. Any dressing is apt to get soaked with urine, and should be replaced daily or oftener in infants. When the parts are at all swollen, or where erections are likely to be troublesome, I prefer boracic acid dressings, two layers of boracic acid lint wrung out of an iced saturated solution of the lotion. The deeper layer has a hole cut to allow of micturition, and is only removed by the surgeon; the outer one envelops the whole penis, and may be removed and rewetted by the patient, though usually it is sufficient for him to keep it wet by dropping on a little lotion from time to time. For children I do not like a gauze dressing saturated with either collodion or tinct. benzoin., for both are irritating, also difficult to remove. Urine generally soaks under them after a day or two and decomposes between the glans penis and the crusted dressing. Erections are frequent and painful with these unyielding applications.

After circumcision the patient should rest as much as possible. Thus an adult should stay in bed for forty-eight hours and keep on the sofa for a week, alternate stitches being removed at intervals. If he insist on getting about too early, he must run the risk of the parts remaining long cedematous and tender. And for this reason, with hospital patients, who have to come backwards and forwards, early and complete healing is not to be expected.

AMPUTATION OF THE PENIS (Figs. 292—295).

Indication.—*Epithelioma of Penis.*—I would refer my readers to the remarks made in Vol. I., p. 578, on the pre-cancerous stage in epithelioma of the tongue. Though epithelioma of the penis is much less common, lives are here also too often lost by allowing the case to go beyond this stage. Any suspicious excoriation, ulceration, or wart should be early destroyed with the acide nitrate of mercury, or excised. Where, after this treatment, satisfactory healing does not take place, early and thorough removal of the part should be performed. There should be no dangerous waiting because the surgeon is unable to satisfy himself whether the case is one of inflammatory induration or infiltration from new growth. In such cases, especially where there is a doubtful history of syphilis, much valuable time has been often lost with drugs, which, even if the lesion does date back to some long-past syphilis, are quite useless if epitheliomatous ulceration has set in. Furthermore, the longer ulceration continues, the more extensively will the inguinal glands be involved. In such cases, though the penis may be satisfactorily operated upon, disappointment will speedily follow, owing to the outbreak in the inguinal regions. Scarcely any surgical case presents a close more distressing, both to the patient and those around him, than one of breaking down of epitheliomatous glands, owing to the hideous ulceration, the noisome discharge, and the steady decay of bodily strength.

In a very few cases, when the disease commences around the meatus, it may still be possible to remove the affected part without interfering with the body of the penis. It seldom happens, however, that we see the case early enough for this, and it is usually necessary to remove the

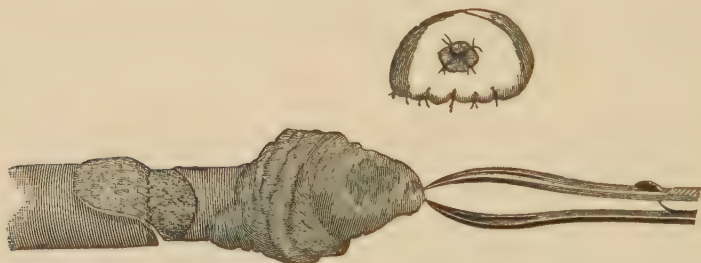
whole of the glans and more or less of the corpora cavernosa. Before doing this the prepuce, unless it admits of being retracted, should invariably be laid open, so as to expose the growth and make quite sure of its real nature. The parts should be cleansed, as far as possible, by shaving the pubis and applying fomentations to the penis for two or three days before the operation. When the patient is anæsthetised, the surface of the growth is seared with the thermocautery to avoid septic and malignant infection of the wound.

Operations.

I. **Circular Amputation.**—This gives good results, though not equal, in my opinion, to those which follow the flap method. The vessels being commanded by a rubber tubing used as a tourniquet, the skin is drawn a little forward to prevent any superabundance afterwards, and the amputation is effected by a single sweep of the knife. The vessels and the urethra are treated as directed below.

II. **Flap Amputation** (Figs. 292, 293).—This method has been followed by rapid healing, and has given an excellently covered stump in

FIG. 292.



Flap amputation of the penis. The appearance of the stump, with the urethra slit up and stitched *in situ*, is shown above. The flap has been raised too near the disease below.

the eleven cases in which I have made use of it. Hæmorrhage having been provided against by one of the above-given means, the surgeon enters a narrow-bladed knife, at a point well behind the disease, between the corpus spongiosum and the corpora cavernosa, and then cuts forwards and downwards for about three-quarters of an inch. From this small inferior flap the urethra is dissected out. A flap of skin is now cut from the dorsum and sides of the penis, resembling in miniature the upper skin-flap in amputation of the thigh. This flap being held back, the corpora cavernosa are divided vertically upwards on a level with the point of transfixion. Any vessels which can be seen are now tied with chromic gut or boiled silk. On removal of the drainage-tube, clamped with Spencer Wells's forceps, and securing any spirting vessels, free oozing often takes place, but ceases spontaneously. All hæmorrhage being arrested, the upper flap is punctured, and the urethra drawn through the face of the flap, slit up, and stitched *in situ*. The two flaps, upper and lower, are then united by a few points of carbolised silk and horsehair suture.

This method secures a natural skin-covering for the severed corpora cavernosa, and prevents the delay and irritation which healing by granu-

lation entails. A similar operation was long ago suggested by Prof. Miller, of Edinburgh, but this surgeon cut his flap from below. If, as I have recommended, the flap is taken from above, the skin will be found to fall into position more readily over the raw surfaces of the corpora cavernosa. After all these operations the patient should pass a short piece of bougie at regular intervals.

III. **Galvanic Cautery.**—I am as much against this method here as in the case of the tongue (Vol. I. p. 600). The dread of hæmorrhage still induces some to resort to it. It is not, however, a sure preventive. Sharp bleeding has followed a few hours after the operation, and also, later on, during the detachment of sloughs. Furthermore, this operation leaves a much more troublesome and sloughy wound than the knife.

FIG. 293.



A case of amputation of the penis by the flap method one year and a half after the operation. Scars of operations for the removal of glands (enlarged inguinal glands were removed at the time of the operation) are seen in either groin. The two dots mark the points where drainage-tubes were brought out. The patient died two years after the amputation of gland disease. There never was any recurrence in the penis. (*Diseases of Male Organs of Generation.*)

This is not a matter of slight importance in these patients, in whom, usually advanced in years or prematurely aged, pulled down in health, and often depressed in mind, tedious healing of the wound, which it is difficult to keep sweet, involves keeping the patient on his back for a considerable time, with the risks of broncho-pneumonia, erysipelas, &c. The need of a special, expensive instrument, and the unpleasant fœtor of the operation, are also objections.

If the surgeon make use of it, a No. 4 or 6 catheter should first be passed; the loop of wire is then tightened around the penis, well behind the disease, and kept there by one or two pins. When the current is passed, care must be taken that by tightening the wire very slowly and watching the amount of heat the vascular structures are not severed too quickly, otherwise hæmorrhage, very difficult to arrest on a seared

surface, is certain to follow. The catheter is cut through by the heated wire, and the urethra, thus maintained patent, is slit up and stitched as directed above.

Occasionally **severer operations** are entirely justifiable.

Thus, where the penis is involved as far back as the scrotum, the entire penis should be extirpated, if the inguinal glands are not seriously involved, and if the powers of repair are satisfactory. The patient being in lithotomy position, the scrotum is to be split deeply along the whole length of the raphé, and the corpus spongiosum carefully dissected out. This step may be facilitated by passing a large sound. When the triangular ligament is exposed, the above instrument is

FIG. 294.



Appearance of parts after amputation of two-thirds of the penis by splitting the scrotum. The patient refused castration. The urethra is at the lowest part of the scar. (*Diseases of Male Organs of Generation.*)

removed, and the corpus spongiosum which has been dissected out is cut through, enough being left to bring out in the perinaeum. By means of a blunt dissector, the crura are then detached on either side from the pubic arch, and, the incision being prolonged around the penis above, the suspensory ligament is divided, and the dorsal arteries secured. The cut end of the corpus spongiosum is now slit up and stitched in the posterior part of the scrotal incision, and all the rest of the wound closed by sutures. Drainage must be provided by a small tube, or by horse-hair drains. Similar operations to the above have been performed on several occasions, but the important modification of dissecting off the crura, and thus ensuring complete removal of the cancerous organ and its capsule, was brought before the notice of English surgeons by Mr. Gould (*Lancet*, May 20, 1882, p. 821).

In most cases of amputation of the penis the patients will be wise in consenting to castration—an operation which will add in many cases largely to their comfort, and at a very slightly increased risk (Wheelhouse, *Brit. Med. Journ.*, 1886, vol. i. p. 187).

Question of removing Enlarged Glands.—These should always be extirpated at the same time as the amputation of the penis, together with as much of the lymphatic vessels and surrounding cellular tissue as possible, preferably in one piece in order to avoid the escape of cancer cells into the wound. As long as the glands are involved by

FIG. 295.



The appearance of the parts a month after complete amputation of the penis, castration, and removal of enlarged glands. The opening of the urethra is not seen, being situated at the perinæo-scrotal junction. The dots mark the counter-punctures for drainage-tubes. (*Diseases of Male Organs of Generation.*)

growth only, hard and separate from each other, it will be comparatively easy to accomplish this, and thereby add materially to the prolongation of the patient's life. But where they contain not only secondary deposits, but also inflammatory matter, owing to ulceration having set in at the seat of the primary lesion, satisfactory removal of the glands is always a matter of great difficulty and often impossible, owing to their softness and tendency to break down, to their adhesions to their capsules, and the matting of these to the surrounding parts, the vascularity of which is increased, and tendency of the overlying skin to become adherent. When the growth becomes adherent to the femoral or iliac vessels, no attempt should be made to remove it, for the main

vein may have to be sacrificed, with resulting œdema of the leg. The removal is very likely to be incomplete, and to be quickly followed by recurrence and hæmorrhage.

In all such operations especial care should be taken to ensure asepsis, and to avoid laceration of the tissues, as sloughing and superficial gangrene or delayed union are apt to follow these operations, which open up important fascial planes.

Antiseptic dressings are the safest to use in this region.

For much fuller information on this and many other points I may refer my readers to my *Diseases of the Male Organs of Generation*, pp. 707—745.

CHAPTER XIV.

OPERATIONS ON THE SCROTUM AND TESTICLE.

**RADICAL CURE OF HYDROCELE.*—VARICOCELE.—
ANASTOMOSIS OF THE VAS DEFERENS.—CASTRATION.—
ORCHIDOPEXY.**

RADICAL CURE OF HYDROCELE.

In a paper written thirty years ago (*Lancet*, Sept. 1, 1877), I drew attention to the uncertainty of the radical cure of hydrocele by iodine injection as usually practised. Thus, out of 44 cases treated with solutions of iodine and potassium iodide at Guy's Hospital, I found that the treatment failed in 8 cases, and that in 2 it failed twice.

Latterly I believe that surgeons have recognised that the risk of recurrence is greater than that of excessive inflammation, and thus stronger solutions have been made use of—*e.g.*, the Edinburgh tincture of iodine—and some of the injection has been allowed to remain. As it is still a fact, however, that no one method of cure can always be relied upon as radical for this troublesome complaint, the four following will be mentioned here, viz. :

- i. **Partial Excision.** ii. **Eversion of the Sac.** iii. **Iodine Injection.** iv. **Injection of Carbolic Acid.**

With the great strides that have been made towards the perfection of aseptic surgery, injection of irritants has become less and less common, so that at the present time it is rarely performed. Under aseptic conditions excision of the parietal part of the sac is no more dangerous than injection, and it is far more certain to cure. Moreover, it is no longer necessary to use a general anæsthetic in all cases, for safe and efficient local anæsthesia suffices when the former is contra-indicated or declined. There are still many elderly patients, however, who wish for nothing more than the temporary, and sometimes prolonged, relief that simple tapping affords. Others decline all cutting operations. In them, and under circumstances which are unfavourable for resort to radical operations, injection may still be tried, and therefore a description of this method is retained in this book, although the writer does not use injections in any case.

* The methods of injection given below refer to hydrocele of the tunica vaginalis and to encysted hydrocele. Antiseptic incision and partial excision of the sac is applicable to all varieties of hydroceles, including the congenital.

I. Partial Excision of the Sac.—This latter is often spoken of as excision of the tunica vaginalis. As the parietal layer of the serous membrane can alone be removed, I prefer the above title.

(A) Advantages.

(1) Its greater certainty. While it is right to remember that no method can be absolutely relied upon as radical, and that hydroceles have recurred even after incision and partial excision of the sac,* there can be little doubt that this must be extremely rare, since after efficient removal of the parietal layer of the tunica vaginalis the cavity must, with very few exceptions, be entirely obliterated. A method which further removes a large part of this secreting surface must *à priori* be surer than those methods which do their work, as it were, in the dark, in which the drainage must needs be imperfect, the quantity of the irritant employed necessarily limited, it being thus always left doubtful how far the injection has been weakened by dilution or chemical change, and how far folds of the inner surface of the tunica vaginalis have escaped inflammation at all. On this account I prefer to make use of partial excision in all cases where the general condition of the patient is satisfactory, and where he is willing to lay up for a short time.

The cases to which this method appears to me to be especially suitable are those where (α) iodine or carbolic acid has previously failed, (β) where the sac is very large or has very thick walls. Where the sac is simply very large, but not much thickened, it can be safely and successfully injected, if this is preferred, by tapping first and then allowing only an interval of two or three weeks to elapse before the sac is injected. But if the walls are much thickened, there are the risks that after tapping they cannot collapse readily, and so be brought in contact with the irritant, and while in a sac like this it is always uncertain if the due amount of inflammation will be secured, there is also a risk that, owing to the little vascularity of a thickened sac, sloughing may take place. (γ) Where, on account of ill-health or age, the risk of inflammation after injection of an irritant is especially to be dreaded. (δ) Where the surgeon is desirous of exploring the sac of the tunica vaginalis, as in cases where enlargement of the testis of a doubtful nature coexists with hydrocele, and does not yield to ordinary treatment, where a hæmatocele has supervened on a hydrocele, or in the much rarer cases of loose bodies in the sac of the tunica vaginalis. (ε) Where several hydrocele, co-exist—*e.g.*, either double hydrocele of the tunica vaginalis, or a vaginal and encysted hydrocele. (ζ) In certain cases of hydrocele complicated with hernia—*e.g.*, (1) in young subjects, where a radical cure of both is desired; (2) in much older patients, where the hernia is irreducible, where, especially in unhealthy patients, there is a risk of the inflammation set up by the injection extending to the

* On this point a valuable paper by Mr. H. Morris, followed by an interesting discussion (Med.-Chir. Soc., Feb. 28, 1888), should be consulted (*Brit. Med. Journ.*, March 3, 1888). Two cases of recurrence after partial excision of the sac were related. Mr. Pollock mentioned one even more extraordinary. This recurred repeatedly—*i.e.*, after two injections with iodine, the introduction of a silver wire seton, and “ample supuration”; finally, the sac was laid open and lint inserted for a fortnight. The hydrocele again recurred and the patient declined any further treatment than simple tapping.

sac of the hernia. (7) In cases of congenital hydrocele a careful incision with antiseptic precautions will be safer than any other method of radical cure if the pressure of a truss for the obliteration of the communication with the peritonæal sac cannot be persevered with. And the same course will be wise in the case of encysted hydroceles of the cord, when their important surroundings, mobility, and their difficult fixation before injection are considered.

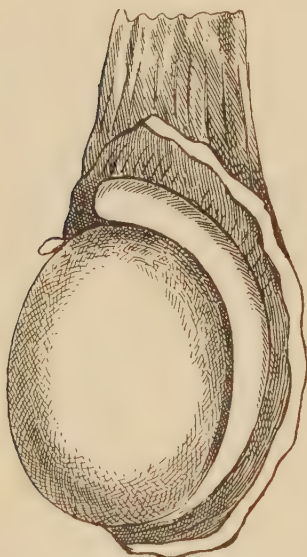
(B) The **disadvantages** of this method must next be considered.

(1) As pointed out in my paper in 1877, it undoubtedly involves more **trouble** than that by injection. While it can be completed in a quarter of an hour, some anæsthetic will be required, and there is the trouble of the subsequent dressings, and there is also more need of absolute rest. Thus the patient will be confined to his bed for a week or ten days, and after this will have to keep quiet on a sofa or in an armchair. (2) With regard to the amount of **subsequent orchitis, pain, swelling, &c.**, I am of opinion that this varies, but not as much as after iodine injection. In the early days of this method—the Schnitt method of Volkmann—when, after incision of the tunica vaginalis, this cavity was carefully plugged with strips of aseptic gauze to promote changes in the serous membrane, orchitis to a painful degree was not uncommon; but of late years, when, after incision of the sac, the parietal layer of the tunica vaginalis is gently detached from the scrotum and cut away close to the epididymis and the testis, I have been extremely struck by the very small amount of pain suffered, in spite of the disturbance and the handling entailed of the parts concerned. (3) With regard to **the duration of the after-treatment**, this is in favour, but not so distinctly as would appear at first sight, of the injection method. With regard to the injection of carbolic acid, this is most certainly so (p. 739). Iodine has also an advantage in time less clearly marked. Thus, after injection with carbolic acid, the patient may perhaps not have to lay up at all. After forty-eight hours he will probably be able to follow his employment if not an arduous one. After the use of iodine the patient will probably be able to get about after the first week. But these dates are only approximate. Even with regard to carbolic acid, it is impossible to read through a large number of cases reported by American and other surgeons without seeing that inflammatory reaction, crippling to locomotion, does occur more frequently than would be gathered from the reports of those surgeons who have advocated it most strongly. And again, as is shown above, while carbolic acid is extremely convenient, it is clear that there is no absolute certainty about it, and that repeated injections have been called for in many cases. After iodine injection the scrotum is often not its natural size, and the patient not free from all encumbrance till between the second and the third weeks. By the latter date, after partial excision of the sac, the patient will be quite well and able to get about. (4) As to the risks of hæmorrhage, cellulitis, and sloughing, which have been described by some writers, I can only say that I have never seen them in an experience of 21 cases of antiseptic incision and of antiseptic incision and excision of the sac.

Operation.—The patient having been prepared for the operation, the parts shaved and well cleansed with soap and water used with a flannel, and then washed with a dilute solution of carbolic acid or mercury

perchloride,* ether or A.C.E. is given. The surgeon, the scrotal tunics being made tense by his left hand or by an assistant,† incises them down to the hydrocele from the top to the bottom of the swelling, and then, before opening this, arrests any bleeding points by applying Spencer Wells's forceps. The hydrocele is then opened sufficiently to admit a finger, which makes out definitely the position of the testicle; the tunica vaginalis is then freely but carefully slit up with blunt-pointed scissors. As, when the hydrocele is opened, the fluid escapes with much force, the sac at once collapses into folds, and scissors will be found preferable to the knife. The incision into the tunica vaginalis

FIG. 296.



Radical cure of hydrocele, to show the extent to which the tunica vaginalis is removed. (From Lockwood's *Hernia, Hydrocele, and Varicocele*.)

should be as free as is safe, for a free incision will at once admit of rapid removal of the parietal layer and a thorough examination of the recesses of the serous sac. If a small one only is made, owing to the contraction of the dartos, the above steps will be found impossible. Further, a large incision is, by the above, soon folded into a little space, and heals as quickly as a small one. Spencer Wells's forceps are then applied to every bleeding point in the cut edges of the sac. The forceps on either side serving to widely open out the wound, the testis and epididymis are examined for any cysts, sometimes present about the head of the latter. The inner surface of the tunica vaginalis is carefully scrutinised for any fibrous bodies attached or loose in any of its folds, or for false membranes and thickenings. As any of these may, by keeping up irritation, lead to a recurrence of the hydrocele, they should be dealt with, the cysts being snipped away after ligature of their pedicles with fine catgut. The parietal layer of the tunica vaginalis is now gently detached, or peeled away from the scrotum as far as is safe—i.e., close up to the

* As it is of the utmost importance that there should be no irritation or erythema set up, which may cause discomfort and subsequent restlessness and also suppuration and slowness of healing, the antiseptic solutions, which are all irritants, should be used both before or during the operation, as dilute as is safe to the very delicate scrotal skin—e.g., carbolic acid 1 in 30 and mercury perchloride 1 in 4,000. For the same reason no scrubbing with a nail-brush is advisable. These may seem trifles, but they may have a very important bearing on the after-result. To promote relaxation of the dartos and prevent contraction, and thus curling in of the skin, warm solutions should be used.

† The position of the testis should first be made out by translucency. The more showy step of opening the hydrocele at one cut might endanger the cord and testicle.

detachment and minimise hæmorrhage, care must be taken to find the proper layer, and to keep in contact with the dense white tunica.

If any false membranes are now present over the testicle and epididymis or the small part of the parietal tunica vaginalis that remains, these are to be detached with a sharp spoon. The bleeding which follows may be smart and require very hot saline solution or firm pressure with a sponge.

Mr. Lockwood recommends that the top of the incision should be a full inch from the root of the penis; that any upward prolongation of the hydrocele along the cord should be dissected out; that in cases where the origin is doubtful, or where the hydrocele is large and of long standing, and the testicle may be wasted, it is wise to obtain permission beforehand to remove the testis. Mr. Lockwood finds it easier to separate the tunica vaginalis while still distended. It is, he believes, quite unnecessary to paint the tunica vaginalis vera with chemical irritants, or to injure it mechanically. On this point readers should refer to the footnote at p. 736.

At one time it was considered to be necessary to suture the remaining edges of the tunica vaginalis to the skin for three or four days, and even to apply chemical irritants to the visceral serous membrane, but experience has shown that these procedures, which delay healing, are not essential to success. It is better to drop the testicle back into the scrotum and to close the skin wound in the usual way with horsehair or catgut. In some cases it is wise to leave a temporary gauze drain in the lower part of the wound, for otherwise a hæmatoma may follow the removal of a large hydrocele, but this is best prevented by firm bandaging. Recurrences after this method are very rare. Immediate closure of the whole wound in this way results in more rapid healing and earlier convalescence. The sutures having been introduced, it only remains to dust a little iodoform over the wound, dry this most scrupulously, and apply the dressings. Whatever material is used, care must be taken that the dressings should supply the following conditions—viz., they must be aseptic, duly compressive, and unirritating. They are secured in place by firm and even bandaging with a double spica. While this is applied care must be taken that the scrotum is kept well up on to the pubes. This is a cardinal point, and must be attended to not only now, but later on, at and after each dressing. It prevents œdema, bagging, and inflammation, and thus also pain, and hastens rapid repair of the wound. When the dressings are *in situ*, a pad of carbolised tow should be kept over the anus, to prevent flatus or fæces contaminating the closely adjacent wound. If the skin incision has been closed, the wound will be healed in a week; by the fifth or seventh day the patient may get on to a sofa, and by a date varying from the fourteenth to the twenty-first day he may usually begin to get about with a suspender. As the repair with aseptic wounds is rapid, but often filamentous and weakly, I advise the use of a suspender for six months or a year after the operation, and longer if occasions arise for hard exercise, such as riding, &c.

Hydroceles of the canal of Nuck and encysted hydroceles of the cord are best excised if they give rise to pain or inconvenience. Encysted hydroceles of the epididymis rarely attain a size large enough to cause much trouble. When they do they may be excised, care being taken to

remove the whole sac. No operation is to be undertaken for the multiple small cysts that form in some elderly men as a degenerative change.

II. Eversion of the Tunica Vaginalis (Jaboulay).—Under local or general anæsthesia, the tunica vaginalis is exposed anteriorly, and incised sufficiently to allow the testicle to be brought out. Traction is made upon this organ while the scrotum is held. Thus the tunica vaginalis becomes completely everted, so that its serous surfaces face outwards. It is secured in this position by means of two or three catgut sutures, which are passed near the edges, which are now posterior and surround the spermatic cord. Care must be taken that the stitches do not compress or injure the cord. Sutures are not always necessary when the opening into the tunica vaginalis is made only just large enough to allow the testicle to be prolapsed. The testicle is then replaced in the scrotum and the wound closed. The endothelial surface of the serous sac now faces the scrotal fibrous and areolar tissues, to which it generally becomes adherent in a short time.

At first it was considered to be necessary to shell the unopened tunica vaginalis and the testicle out of the scrotal coverings, in order to obtain proper eversion, but this step is superfluous, and is attended with more or less hæmorrhage. Longuet also made a new cavity for the testicle between the connective tissue layers of the scrotum, but this is attended with dislocation of the axis of the organ, and is not necessary.

This ingenious and simple operation is not so successful as might be imagined, for recurrence has followed it, and a serous sinus has persisted. In other cases the cord has been injured or seriously compressed. But Major Fullerton tells me that it is frequently and successfully used in India.

Longuet records 22 cases without recurrence, and Dudley Tait (*Ann. of Surg.*, 1901, vol. xxxiii., p. 305) records 3 cases. It is not stated how long these patients were observed. The operation has not found much favour in England, because excision of the parietal part of the tunica vaginalis is a more certain and radical procedure. In view of the comparative simplicity of the operation, however, it is worth trying for some thin-walled hydroceles.

III. Iodine Injection.*—Supposing the patient be healthy, not prematurely aged, and amenable to directions, the surgeon often begins with this as less painful, requiring no open wound or dressing, and, finally, as necessitating much less the recumbent position.

I have at p. 733 drawn attention to the frequency with which recurrence is liable to take place if dilute injections are used. Elsewhere I have written as follows: "While I believe that the absolute certainty of iodine injection has been overestimated, yet there is no doubt that failure is too often courted by want of the following precautions: (a) the use of a too dilute solution; (b) not bringing the solution in contact with the whole of the sac; (c) not withdrawing all the hydrocele fluid; (d) injecting large hydroceles immediately after they are emptied; (e) making use of iodine in unsuitable cases—viz., hydroceles with thick walls."

* A 10 per cent. solution of chloride of zinc and a variety of other irritants have been injected, and catgut has also been introduced through the cannula.

The method of injection with iodine should be carried out as follows: The patient's bowels are cleared out for a day or two before, and it is well for him to rest with his hydrocele well supported for twenty-four hours previous to the injection. The fluid is first most carefully drawn off with a medium-sized trocar.* The surgeon then, by means of a syringe with a platinum nozzle accurately fitting the cannula, injects steadily two to three drachms of the tincture of iodine (Edin. Pharm.), taking care first that the cannula is well within the cavity of the tunica vaginalis. I now plug the cannula with a small wooden spigot, while the affected side of the scrotum is gently manipulated and shaken so as to bring the fluid in contact with all the interstices and folds of the serous membrane. In five or ten minutes the cannula is withdrawn, and in most cases it is quite safe to leave in the above-given amount of iodine. The puncture is kept carefully closed around the cannula while this is taken out, and then closed with iodoform and collodion. A feeling of heat is noticed during the injection, sometimes amounting to sickening pain, referred also to the inguinal and lumbar regions, and the neck of the bladder. Faintness is not very infrequent, and it is thus well to tap and inject the patient while he stands at the end of a sofa, or lies down.

The after-treatment depends on the amount of inflammation. In most cases there is too little rather than too much of this. It usually appears within two or three hours, and if it be slight or delayed, the patient should be told to walk about a little, and the sac again frequently manipulated. The patient should be kept to his bed or sofa for a day or two, the scrotum supported, and plain diet given. There should be no hurry to employ ice, this only being made use of if the swelling threatens to be great. Morphia may be given freely. Within four or five days usually the patient may get about wearing a suspender. He should be prepared for a return of the swelling after the injection, otherwise he will be disappointed at what he considers a recurrence of his disease. The swelling, as a rule, disappears in three to four weeks.

In the case of a double hydrocele, if the patient be healthy and not advanced in years, it is quite safe to inject both sacs at the same time, but in elderly or weakly subjects antiseptic incision will be the safest course if the patient desires an operation, otherwise an interval should be allowed between the two tappings.

IV. Carbolic Acid.—This method was introduced in 1881 by Dr. Levis, of Philadelphia (*Boston Med. and Surg. Journ.*, 1881, vol. cv. p. 540). The following *advantages* have been claimed, and in my opinion largely substantiated: (α) It is less painful than iodine. (β) It is more certain. Thus carbolic acid produces almost uniformly the proper degree of inflammation, neither falling short of nor exceeding that needful for producing plastic lymph. (γ) There is less risk of sloughing. (δ) The patient is only kept from his employment for a day or two, and sometimes for a shorter time than this, or even not at all.

While the above advantages of carbolic acid injection over that by iodine, especially the fact that it entails a much shorter rest and absence

* By some a solution of cocaine is now injected. I prefer not to use this, if possible so that no dilution of the iodine injection may occur.

from business, have, in my opinion, been largely substantiated, it is certain that complications and undesirable sequelæ, while less frequent, are not so entirely uncommon as some partisans of this method would have us believe. (1) **Recurrence.**—With regard to this matter, I would point out that a large number of cases have been published as radical cures within a year or so of the first introduction of the method. Thoughtful surgeons who have seen much of radical cure of hydroceles will not need that I should refer them to the remarks which I have made on the rebellious nature of many hydroceles, and how they must be carefully watched for an extended period before a radical cure can really be claimed. It is beyond the bounds of probability that while a hydrocele will recur after careful incision and drainage, and even after incision and partial incision of the sac, injection of carbolic acid will be invariably and permanently successful. And it is interesting to note that in America itself, where this method has been most largely used, and where surgeons have had the largest opportunities of watching its results, they are not in entire accord as to its value.

Thus Dr. Bull, of New York (*Ann. of Surg.*, July, 1886, p. 35), in a paper recommending antiseptic incision, writes: "It is a striking fact that, of the 13 cases I have met with, 2 had been treated unsuccessfully in this way. As it attempts a cure by the same process as that incited by iodine, an adhesive inflammation, I see no reason to believe that it will ever yield much better results." Dr. R. F. Weir, in the discussion that followed on the reading of the above paper, said he had used carbolic acid injections over sixty times. Occasionally relapses had occurred, not in a large proportion, however, as he could recall only four or five instances, and in those the patients were cured by a repetition of the same treatment. In three of those the injection was repeated too soon, as subsequent experience showed that a longer delay would probably have resulted in a cure. Helferich, of Griefswald (*Therap. Monatsschrift*, 1890), has tested carbolic acid injection by Levi's method in over 30 cases, with known results in 27; 21 were cured, 6 relapsed, all of these latter, save one, being cured by a fresh injection.*

(2) **Much Reaction. Cellulitis and Suppuration.**—It is right to say that in some of the cases in which these have followed on the injection of carbolic acid an excessive quantity seems to have been employed. Thus Dr. R. Abbe (*New York Med. Journ.*, Dec. 22, 1883) reports that he injected three drachms of carbolic acid and glycerine into a large hydrocele sac, and that acute suppuration followed, requiring incision, which cured the hydrocele. He allows that the above quantity is excessive, one drachm always sufficing. Dr. Weir (*loc. supra cit.*), in one case in which the iodine treatment had failed, injected three drachms of carbolic acid; this was followed by the usual absence of pain, but with recurrence of the swelling in a few days, which went on to suppuration, and after incision of the sac shreds and large masses of membrane were discharged, gangrene of nearly the entire tunica vaginalis being produced.

* Mr. Southam (*Lancet*, 1887, vol. ii. p. 515) mentions a case which recurred within a month of the injection with carbolic acid, and was then treated by antiseptic incision and partial excision of the sac.

The above cases of Weir and Helferich show that accidents have followed even when the amount of carbolic acid used is small. They suggest that, considering the comparatively recent introduction of this method, and the restricted number of surgeons by whom it has been used, complications are at least as frequent as after iodine injection.

(3) **Carbolic Acid Poisoning.**—Most writers have distinctly stated that this does not occur. It is certainly extremely rare, as it is probable the surfaces are sealed by the carbolic acid.

But Dr. J. Murphy, at a discussion at the New York Association (*New York Med. Record*, June 20, 1891), said he had known of three or four cases in which carbolic acid used in this way was followed by bad effects, especially on the kidneys. He had seen one case terminate fatally, and he could not attribute this death to anything but carbolic acid poisoning. He did not know how much carbolic acid was used. I know of one case of death from pulmonary embolism a few days after injection of carbolic acid. Hæmorrhage into the sac may also occur.

The Injection.—After the usual tapping Dr. Levis, by means of a syringe which has a nozzle sufficiently long and slender to reach entirely through the cannula, injects about a *drachm* (of crystals) of carbolic acid, which must be kept liquid by a 5 or 10 per cent. addition of glycerine or water. The former should be preferred. No more fluid is to be used for dilution than is absolutely necessary. Liquefaction by heat is inadmissible, as solidification is in this case liable to follow in the cannula. As soon as the carbolic acid is lodged in the sac the scrotum is freely manipulated, so as to diffuse the carbolic acid uniformly. A sense of warmth is produced, quickly followed by decided numbness.

My own experience is too limited to be of any value. Of late years I have used antiseptic incision with partial excision of the sac, and have been so well satisfied with it as to prefer to use it wherever the patient can lay up. But where this is objected to, I have used iodine and carbolic acid, but the latter only in 11 cases. None have recurred to my knowledge, and some have been watched for over three years. There is no need of Levis's special instrument. What is essential is to use carbolic acid liquefied with glycerine, not to inject more than one drachm, and to lodge it well within the tunica vaginalis. This may be done by means of one of the large exploring hypodermic needles, which hold 60—100 minims.*

The needle attached to the syringe is first lodged safely in the cavity of the hydrocele, which is then tapped in the ordinary way with a fine hydrocele-trocar. When the sac has been thoroughly emptied, the cannula is withdrawn, and the syringe, previously cleansed, containing the solution must be screwed on to the needle, which has been kept *in situ* and the solution injected. However this is done, the carbolic acid must be brought in as complete contact as possible with the interior of the sac by manipulating the scrotum, turning this from side to side, upside down, &c. I have employed strapping or suspension with cotton wool packing later, as after the use of iodine.

* I learnt the value of these in small hydroceles, as in those of the cord, or the infantile variety in boys, from the late Mr. Berkeley Hill (*Brit. Med. Journ.*, 1886, vol. i. p. 1164). Following Mr. Hill, I have also given an anæsthetic in children.

VARICOCELE.

Indications.—While palliative treatment will be sufficient in the great majority of cases, if, at the same time, due attention is paid to the general health, the occupation and habits of the patient, and, where this is required, to his sexual hygiene, an **operation** will be **justifiable** in the following cases :

(1) Where the patient is precluded from entering one of the public services, or any occupation involving much activity in the upright position. Thus, out of the 28 cases in which I have operated, 12 were private cases, of which 9 were applying for and passed into the army or navy, and 1 was a medical man, operated upon for double varicocele; of 16 hospital cases, 1 was desirous of entering the police and subsequently did so; 1 was a goods-guard on probation, and found that a large left-sided varicocele threatened to spoil his prospects, the aching pain, which invariably followed the jumping in and out of his brake van, being only relieved by the patient's lying down, and being inevitably brought on again by the next station. This man stopped me on London Bridge some five years after to say that he was in regular employment as a goods-guard, married, and the father of two children. Five others were shop assistants, and 2 were gardeners. (2) In any case where the varicocele persists or steadily increases, in spite of treatment, and where it is accompanied with much distress, annoyance, or pain, or where it interferes with some justifiable pursuit, such as riding; (3) where the patient is going to reside in a hot climate, where a small varicocele soon enlarges from want of support from the atonic cremaster and dartos; (4) where the surgeon has satisfied himself that the testicle is undergoing atrophy; (5) where the varicocele is accompanied by frequent seminal emissions and much mental misery. In the two last given indications, great caution must be shown before operation is resorted to, and the last is the most doubtful of all. Where the patient is clearly a hypochondriac, or a monomaniac in genital matters, no operation is, of course, to be thought of. It is certain to be a failure.

The choice of operation is a very large one, but as I consider that one alone has been proved to be alike efficient and simple, I shall not occupy my space with an account of any others, or with the history of the operation. Like so much else in operative surgery, the only efficient and simple operation for varicocele dates to the great discovery of Lord Lister.*

Excision.—This operation, performed with the parts well in sight, has the very great advantage of allowing the surgeon to carry out each step with precision, to include what he thinks safe, and no more; it does away with the risk of transfixing a vein, and its possibly disastrous results of septic thrombosis; it requires very few and simple instruments; while Lord Lister's teaching has enabled us to perform it without the risks of hæmorrhage, cellulitis, and blood-poisoning, which were so terribly frequent in operations on veins performed before his day.

* Sir Henry Howse drew attention to the method of aseptic excision in varicocele (*Guy's Hosp. Reps.* 1887, vol. xxiii. p. 408).

For a few days before, the bowels should be kept well open, and the diet should be light and limited. The parts should be shaved and thoroughly cleansed with soap and water, and then lotio hydr. perch. 1—4,000 (p. 736). It is well to perform the cleansing twelve hours before, and to keep a compress, wet with the above lotion, on up to the time of the operation. The patient having been anæsthetised with ether or A.C.E. mixture and the field of operation isolated with aseptic towels, the vas deferens is isolated, and either kept so by two fingers of the left hand, or handed over to an assistant, who stands on the opposite side to the surgeon. In either case the latter makes the veins prominent by grasping the affected side of the scrotum and protruding the varicocele. The skin incision, which should be about an inch and a half long, may be made in one of two ways, either in the scrotum directly over the site of the varicocele, or above the scrotum and in front, commencing at the external abdominal ring and running downwards towards the scrotum. If the latter plan is adopted it will be found that the varicocele is quite easily pushed up into the wound, and it has the advantages of rendering the operation more convenient, whilst the wound is more easily sutured and heals more certainly and readily than one which involves the skin of the lower part of the scrotum. Further, the spermatic veins are less numerous, and more easily separated from the vas, than lower down, and the tunica vaginalis is very unlikely to be opened. The exposed skin around the wound is covered with aseptic lint, which is fastened to the edges of the wound with tissue forceps, so that neither instruments nor sutures may touch the skin. The surgeon either wears gloves, or scrupulously avoids touching any of the tissues with his fingers, but does all the work, including the threading, holding and tying of the ligatures, with suitable instruments.

Care should be taken to avoid opening the tunica vaginalis. If, however, it is opened, the opening should be taken up with Spencer Wells's forceps and tied up with fine catgut, or it may be left without treatment. If the wound runs an aseptic course, this complication will give very little trouble. With one or two strokes of a keen-edged scalpel the packet of veins is exposed and is then carefully opened. The surgeon then passes a steel director first at the upper and then at the lower angle of the wound through the packet so as to leave less than a third of the veins behind it. Along the director, which thus keeps a track open and easily found, an aneurysm-needle, or eyed probe, carrying a medium-sized ligature of sterilised catgut, is passed. This is then tied firmly round the included veins. If the incision has been made an inch and a half long, and the upper and lower angles of the wound are well retracted, no difficulty will be experienced in placing these ligatures near enough to the external abdominal ring and testicle respectively to ensure removal of a sufficient extent of the enlarged veins. After each of the ligatures, upper and lower, has been tied securely and cut short, a pair of scissors is run along the director, and the packet is cut through about a quarter of an inch from each ligature. The portion of varicocele thus included is then removed by carefully clipping it out with a pair of scissors; any cross branches which may now be divided are secured with fine chromic gut. An extremely important step comes next. With a sharp-pointed

half-curved needle, carrying medium-sized chromic gut, the surgeon brings into accurate apposition the two ends of the stumps, the ligature being passed through the centre of each stump close to the corresponding ligature. As it is tightened an assistant, with a sharp-pointed probe, brings the cut ends of the veins on the face of each stump snugly and precisely together. The object of this most important detail is to permanently shorten the cord, and to restore the natural suspension of the testicle.* It is obviously quite impossible in any subcutaneous method. I have practised this detail since 1887, but as Sir William Bennett was the first to draw attention to this step (*Lancet*, February, 1891), the credit of showing the importance of it must be his. The sutured cord is replaced in the bottom of the wound. When the skin is much relaxed, I finish the operation by removing widely, by two elliptical incisions, the skin on either side of the small wound which has been made, the apex of the incisions being placed well up over the external ring. I think it well to adopt this step, as I believe it helps to brace up the relaxed parts; but it is not of the least use by itself, and it is much less needed now if the above-given precaution of ligaturing together the vein-stumps, and thus shortening the cord, is taken. And the same may be said of another step which should be taken before the close of the operation—*i.e.*, ligature and removal of any very enlarged scrotal veins, a step which I always adopt when the patient's attention has dwelt on these. The whole wound, superficial and deep, is then carefully scrutinised, and every bleeding point being secured is thoroughly dried. The edges of the wound are then carefully adjusted with horsehair sutures, the tendency to inversion being borne in mind.

Antiseptic dressings are then applied, due facilities being provided for the patient's micturition. In securing the dressings *in situ*, care should be taken to keep the scrotum well up on to the pubes by bringing the turns of the spica from below upwards and not in the reverse direction. I generally change the dressings at the end of the third day, immediately after the first action of the bowels, and again at the end of the first week, to remove alternate sutures. At this date the patients may get on to a sofa, but I insist on their maintaining the recumbent position for two or three weeks. Aseptic union, forming quickly and without the medium of granulations, remains weak for a long time. If the stumps of the cord have been sutured together there is much less need for the patient to wear a suspender afterwards; but to give the operation every chance, and to save all drag and tax upon parts which have very recently united, I generally advise that a suspender be worn for three months. In addition to the support which I believe to be advisable while the sutured stumps of the cord are being firmly knit together, I am of opinion that the continuance of support to the parts for a while prevents a too rapid melting away of the little nodular mass, which, callus-like, marks the seat of the operation.

The points to which I attach most importance in the operation are maintenance of strict asepsis throughout, suturing together the two

* The same object may be less perfectly attained by leaving one of the ends of each ligature uncut, and then tying those ends together; the apposition is not so good as that obtained by the method already described.

stumps, and so shortening the cord and providing for suspension of the testicle, arrest of all hæmorrhage, thorough drying out of the wound, and the careful application of an antiseptic dressing, so as to keep the scrotum well up on to the pubes. I look upon these details as most necessary if rapid healing is to be made certain of, and cellulitis, epididymo-orchitis, and hydrocele prevented.

Mr. Bennett (*loc. supra cit.*), in his operation for varicocele, advocates some different and, in two instances, far more radical steps. Thus (α) he does not open the general sheath immediately surrounding the veins, as by leaving it intact he makes certain of passing the ligature around *all* the affected veins, as none of these ever lie outside the fascia. Furthermore, the fascia, if not opened, better carries the weight* of the dependent testicle. (β) Mr. Bennett considers that the view generally held that the spermatic artery is displaced with the vas deferens, and thus kept out of the way, is a mistake; in reality the artery remains with the veins. Furthermore, Mr. Bennett holds that the artery is usually, and may always be, safely divided with the veins, for as long as the wound remains aseptic the artery to the vas deferens "and some outlying branches of the spermatic artery, one of which sometimes comes off high up and so may easily escape division, are sufficient to carry on the blood supply to the testicle, and to prevent any risk of atrophy."

While Mr. Bennett's plan is justified by the results obtained by his own practised hands, I feel that, writing as I am for those who may not have had many opportunities of operating for varicocele, I ought to point out certain grave risks which I consider to be at least possible, if the above teaching is widely followed.

First, as to division of *all* the veins, I will say at once that perhaps I am prejudiced unduly by the unfortunate result of one case, which I mention below. While I admit that recurrence of the varicocele may be brought about by removal of too few of the veins, I feel strongly that inclusion of all of them in the ligature involves a much graver risk. Further, I cannot agree with Mr. Bennett that it is safe to trust to the artery of the vas, or branches of the spermatic which may come off sufficiently high up to be available, and some small unimportant anastomotic branches passing from the sub-vaginal tissue. Mr. Bennett allows that these vessels are small and delicate, and points out that any inflammation about the parts may be sufficient to choke them, sloughing or wasting of the organ following as a necessary result.

Thus, while in no way criticising Mr. Bennett's modifications of the operation when practised by himself, I strongly advise my junior readers to make use of the simpler and very efficient method given at p. 743.

The chief risks and causes of failure in the operation are as follows:—

I. Sepsis and its Results.—The risk of these was always present with the old subcutaneous operations, however modified. It is by no means to be lost sight of with the open operation performed with the advantages of modern surgery. The operation, although it may appear to be trivial, is not one to be undertaken lightly, and it should not be

* This is rendered of less importance by the suture which unites the vein stumps.

performed except under aseptic conditions, lest cellulitis, septic thrombosis, or even sloughing of the testis occur. Short of these catastrophes, suppuration around the ligature may occur unless catgut is used instead of silk, and the precautions mentioned at p. 743 are observed. A troublesome stitch sinus results, and frequently a hydrocele of the tunica vaginalis develops in such cases. I have seen several patients who have had to submit to a radical operation for hydrocele, the sequela of excision of varicocele.

II. Inclusion of too many Veins.—That this is a real danger is shown by a case of mine which I published (*Syst. of Surg.*, vol. iii. p. 571). A transient hydrocele may develop from removal of too many veins, but a permanent hydrocele is very rarely seen apart from a definite history of stitch abscess.

III. Atrophy of the Testis.—This may occur from destruction or injury of the sympathetic nerves of the testis, which run with the vas. In order to avoid this rare sequela, care must be taken to leave the vas well alone; it is not necessary to touch it at all.

IV. Division or Laceration of the Vas Deferens.—This has happened to careless operators more commonly than would be suspected from publications. Atrophy of the testis does not occur if the injury is limited to the vas deferens. The accident is most likely to happen from want of care in separating the lower coiled part of the duct from amongst the bulky mass of veins near the epididymis.

V. Recurrence of the Varicocele.—I am of opinion that if operation-cases were more thoroughly followed up afterwards, this sequela would be found to be more common than is thought to be the case. It is especially likely to follow the subcutaneous method where the patient is allowed to get up, or is hurried out of the hospital to make room for another case as soon as the wound is healed. To prevent this risk of recurrence Mr. Bennett lays stress on the need of removing the entire plexus of spermatic veins. As I have been unfortunate enough to meet with a case in which, in spite of care taken, too many veins were ligatured and removed, I cannot agree with Mr. Bennett (p. 745). Another instance of what appears to be recurrence, but which is really an escape of the upper part of the spermatic plexus, may be due to the upper ligature being applied too low down (Bennett). In this case the part of the plexus between the upper ligature and the external ring remains full, and may give trouble for a time, though it gradually shrinks.

Insecure knotting of the ligature, or not using reliable material,* may, of course, lead to recurrence after any method in which ligatures are used, but the veins are not also divided. It may be truly said that the accidents and sequelæ mentioned above are avoidable by careful and aseptic operating, but the danger of their occurrence is still real enough to justify the warning that this apparently simple operation is not to be performed without due care, and under circumstances which are favourable for aseptic work.

ANASTOMOSIS OF THE VAS DEFERENS.

A divided vas deferens may be anastomosed by slitting the distal cut end for about an inch, so that two flaps are formed by two incisions,

* Mr. Bennett prefers kangaroo-tail tendon ligatures.

one on each side of the vas. One of these incisions is then carried up a little further (half an inch), and the obliquely pared testicular end of the duct is then laid in contact with the lumen of the urethral part, and secured with very fine catgut sutures. The equal tails of the urethral end are then wrapped round the testicular part of the vas, and sutured in position. Layers of fascia are then wrapped round the anastomosis and fixed in position by sutures (Lynn Thomas, *Brit. Med. Journ.*, 1904, vol. i. p. 13).

Lydston (*Ann. of Surg.*, vol. xlv. p. 92) passes a thread of silk-worm gut into both ends of the vas, and brings one end of the thread out through the side of the proximal part of the tube, and later through the skin. The ends of the vas are brought together by two catgut sutures, and the anastomosis is reinforced by folding the "sheath of the cord" around the vas and securing it in apposition by means of a continuous catgut suture. The silkworm-gut thread is removed after ten days.

CASTRATION (Fig. 297).

Indications.

I. *Growths of the Testicle.*

Diagnosis of Malignant Disease of the Testis.—As the records of surgery contain many instances of mistakes under able hands—hæmatoceles removed for malignant disease, and malignant disease opened for hæmatoceles—a few hints may not be out of place here on the subject of castration.

Contra-indications.—Castration should not be performed when the cord is extensively involved, when masses can be felt deep-seated in the iliac fossa and lumbar region, when there is any evidence that the liver or lungs are involved, or when the jaundiced sallow tint and rapid emaciation point to the disease having become general. In cases at all advanced, though the patient might be rid of an encumbrance, the operation would be very liable to be followed by a low form of peritonitis, or, before the wound was healed, swelling would probably appear in the inguinal region, and the growth soon fungate through the wound.

The following are the points on which most reliance may be placed :

Continuous, and often quickly progressing, solid enlargement of the testicle or epididymis without inflammation. Sometimes this progress is much slower ; occasionally it may seem to be in abeyance, but careful watching with frequent examinations (and these are the key to obscure cases) will show that the enlargement is progressing in spite of treatment. Failure of well-directed treatment. Where the swelling is small, still oval in shape, and smooth and firm in outline, a brief trial of mercury or potassium iodide may be made, combined with carefully applied Leslie's strapping, but where in a week there is no result, or where the case is of longer duration, and delay will very likely be fatal, an exploratory incision with antiseptic precautions, followed, if need be, by immediate castration, will be the wiser course.* Consistence. This is rarely for long the same all over the swelling. Even if a firm, slow

* I may warn my younger readers of the temporary improvement which potassium iodide sometimes seems to bring about even in malignant swellings.

growth seem uniform and recall orchitis, a careful examination will usually find one or two spots which are more *elastic* than the rest. Usually the softening at places where cystic or degenerative changes are taking place is well marked. But it may require somewhat prolonged watching to detect one or two at first lowly rising projections or bosses which foretell that the tunica albuginea is becoming thinned at this spot. Of enlargement of the cord,* fulness of the scrotal veins, adhesion of the scrotal tunics, increasing aches and painfulness, I say nothing, as they are evidence that the disease is entering into a later stage.

An exploratory incision is to be preferred to the use of a trocar, as being more certain to give information. A trocar may enter a solid part or withdraw some scanty mucoid fluid. Sometimes the amount of blood which flows through the cannula of a trocar thrust into a testicle, the subject of rapidly growing malignant disease, is so great as to lead to the supposition that it must be a hæmatocele. In such cases, however, the diminution of the swelling is not so proportionate to the flow of blood as it would be in hæmatocele. Furthermore, the blood is usually bright, not dark and altered, as in hæmatocele.

Prognosis.—It will be seen that the prognosis is always grave, extremely so in the softer and more rapid growths. Kocher goes so far as to say with regard to these that no case of really permanent cure of encephaloid carcinoma is known. In medullary sarcomata, especially in children, the prognosis is almost as gloomy. But while the above opinion is only too true of the majority of cases, a sufficient number have been recorded to show the benefit which may follow on castration, even in the soft forms of sarcomata. Kober collected 105 cases of sarcoma of the testis, out of which 9 were known to be free from recurrence over three years after the operation.

Mr. Meade, of Bradford, removed, in 1846, the testicle of a patient aged 40 for a swelling which had lasted about nine months (*Lond. Med. Gaz.*, vol. xlv. p. 702). Nine years later the patient remained free from any return of the disease. In the museum of St. George's Hospital is a specimen of a testicle converted into a mass of soft malignant growth, with large caseating patches, which Mr. Cæsar Hawkins removed from a patient aged 45, the enlargement having lasted two years. Twelve years later this patient was alive, and in good health. In the *Med. Times and Gaz.* 1886, vol. ii. p. 287, a case of Mr. Cock is mentioned in which a patient remained in good health for six years after castration for "medullary cancer," being then lost sight of in consequence of his emigration to Australia.

While these cases are most encouraging, I fear they are exceptional. It will be noticed that in one a swelling had lasted nine months, and in another two years. If it be thought that such cases show that no limit can be fixed beyond which castration must be useless, the following must be remembered. First, is it possible that the earlier enlargement was, for some time at least, inflammatory? Secondly, as a rule, in the softer sarcomata, enlargement of the lumbar glands will be present by the end of the first year of the growth, and often earlier.

* I quite agree with Mr. Butlin (*loc. supra cit.*) that *early* enlargement of the cord is met with in inflammatory conditions of the testicle, and is here a contra-indication to malignant disease.

As a rule, the retro-peritonæal glands and viscera will be involved by extension and secondary deposits within six months of the time of castration. And this result is the more disappointing because the testicle, a free, floating organ, and one placed independently in a fibrous capsule, appears to be remarkably favourably placed for the radical removal of malignant disease. The intimate association of the organ with the lymphatic system, both within itself and with those within the abdomen, and the facility with which these are early implicated, handicap us terribly here.

But if, as happens most frequently, the disease recurs elsewhere after castration, a useful life may yet be prolonged; the patient, rid of a wearisome encumbrance, is made more comfortable; and towards the close death from internal deposits of malignant disease is not accompanied with the same distress both to the patient and those around him as when the disease is situated externally. In proof of the temporary benefit of castration, Mr. Curling (*Diseases of the Testis*, p. 342) relates the case of an eminent barrister, who for two years and a half after the removal of a testicle for soft cancer was able to continue the practice of his profession to the great advantage of his family, death ultimately taking place from extension to the lumbar glands.

II. *Tubercular Testicle*.—I am of opinion that castration should be performed much earlier in this disease than is usually the practice, in order to prevent the spread of the disease along the vas deferens to other parts of the genito-urinary tract. The infection travels upwards to vesiculæ seminales and not in the reverse direction (Baumgarten, German Surg. Congress, 1901). Early excision of the epididymis and the diseased part of the vas deferens may prevent the upward spread, but it often fails to prevent local recurrence. Natural cures are so few, dissemination is so frequent and so grave, whether to the bladder and kidneys, vesiculæ seminales, or prostate, or to the lungs, while, on the other hand, castration is nowadays so safe an operation, that it should not be deferred. Von Bruns (*Cent. f. Chir.*, July 20, 1901) analyses the results of 111 castrations for tuberculosis of the testicle. The operations were performed at Tübingen during the previous fifty years. Forty-six per cent. of the patients submitted to unilateral orchidectomy remained cured from three to thirty-four years, and 56 per cent. of those submitted to castration or removal of both testicles were free of recurrence for from three to thirty years.

Early phthisis should not interfere with removal of a tubercular testis which resists treatment, and prevents the patient getting open-air exercise, and weakens his health by discharge. Owing to the condition of the lungs, chloroform should be here given, instead of ether.

Tubercular disease of the prostate is a source usually of such extreme misery, that any existing cause in the testis should be removed very early. Moreover, from what we have learnt from castration in enlarged prostate (p. 682), removal of tubercular testes may prevent or greatly delay deposit of tubercle in the prostate.

I have only space to mention briefly the indications. (1) Where erosion fails in lesions still limited to the epididymis. If one or more discharging fistulæ still persist here, especially if the patient is not in a position to avail himself of a repetition of erosion and delay, castration should be performed, slight as the mischief appears to be,

especially if they affect the patient's health or interfere with the outdoor exercise so necessary in these cases. It is only too probable that minute deposits are already making their way into the testicle itself by spreading along the rete, a condition impossible to recognise by external manipulation. (2) Where after erosion any fistula has healed, but careful watching of the patient, always to be insisted on, detects the existence of, it may be, slight but persistent swelling in the scrotum, with night sweats and loss of flesh. These may point to mischief in the remains of the sexual gland, and not necessarily to disease in the prostate, &c., or in the lungs. (3) Where the body of the testicle is involved. When this remains enlarged, and liable to attacks of inflammation, castration should be performed. (4) Where the testicle remains atrophied and riddled with fistulæ, one or more of which persist in discharging, removal of a useless and dangerous organ should be practised. (5) When a hydrocele* is present, especially if purulent. When both testes are involved, it is rarely justifiable to remove the two. In young subjects the worst may be removed, and the diseased epididymis and vas deferens may be excised on the least affected side, the testicle being saved for its internal secretion.

If the vas is healthy it may be worth while to implant its open end into the rete testis or the globus major if that body is healthy, as in Hayne's case (*Ann. of Surg.*, 1905, vol. xli. p. 745). The anastomosis failed in this case, for the semen contained no spermatozoa. Martin, however, was more successful, for normal semen was discharged after the vas had been grafted into the tail of the epididymis.

The experiments of Bolojoboff upon animals had already proved the possibility of successfully joining the vas to the epididymis or testicle.

III. *Syphilitic Testis*.—Here, owing to the specifics which we possess, castration is much more rarely called for. The indications can readily be judged of from those above given.

IV. *Old Hæmatocele*.

Indications.—Failure of previous treatment, especially in a man of middle life whose activity—*e.g.*, in riding—is much interfered with.

The frequency with which malignant disease follows on repeated injury and irritation of the testicle is well known (Rindfleisch, *Path. Hist.*, vol. ii. p. 197).

V. *Retained Testis*.

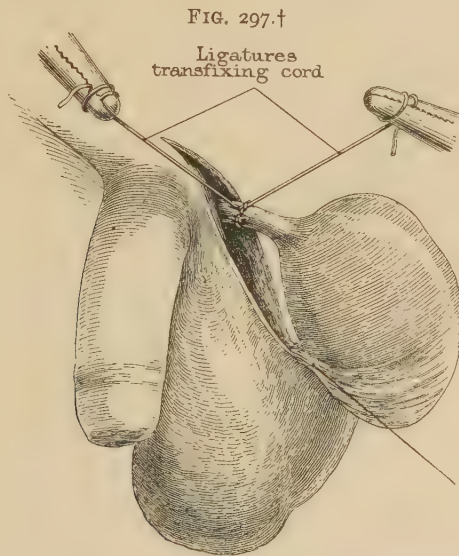
Indications.—(1) When such a testis is the seat of malignant disease. (2) When it seriously cripples the patient by the recurrent attacks of inflammation associated with it. (3) When the testis gets twisted or strangulated and necrotic, as the result of a long meso-testis which commonly exists in these cases. (4) When a co-existing hernia cannot be kept up by a truss owing to the presence of the testis, a radical cure of the hernia should be undertaken, and if the patient be well over puberty, the testis should be removed, for it is very unlikely to be functional, and therefore it is not worth attempting to place and keep it in the scrotum. In a child under these circumstances, especially if he wishes later to enter one of the public services, it is important

* On the subject of tubercular hydrocele, of the influence of co-existing disease in the vesiculæ seminales, prostate, and lungs, on castration, I must refer my readers to chapter vi. of *The Diseases of the Male Organs of Generation*.

to save the organ and perform orchidopexy, as well as a radical cure of the hernia.

VI. *Enlarged Prostate*.—This operation, which was much resorted to a few years ago chiefly through the work done by Prof. J. William White, of Philadelphia (*Ann. of Surg.*, 1893, and July, 1895), has been abandoned owing to the high mortality which attended it, and the uncertainty and incompleteness of the relief derived from it (*vide* p. 682).

Much rarer indications are:—VII. *Insanity, chronic epilepsy, &c., kept up by onanism*.^{*} VIII. *Injury*. IX. *The radical cure of hernia*—i.e., when the operation cannot be completed without removal of the testis, owing to the firm adhesions of the sac to the cord, especially



Castration, scrotal incision for large growths and septic conditions. The cord is transfixed and tied with two interlacing catgut sutures, and one of these is afterwards tied round the whole cord. The upper end of the incision is shown too far in.

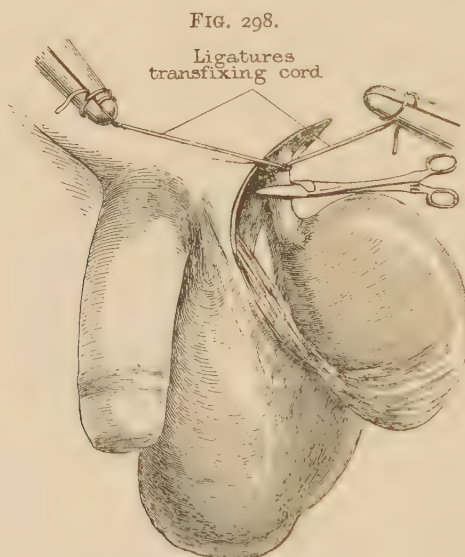
when this occurs in a patient approaching middle age. It is always well here to obtain leave for castration.

Operation (Fig. 297).—Cases in which sinuses and adhesion of the scrotum exist, or very large growths have to be removed. The absence of any hernia on the side operated on having been ascertained, and the parts duly shaved and cleansed, the surgeon protrudes the testicle with his left hand so as to make the overlying tissues tense, and divides them from the external abdominal ring, prolonging his incision as

^{*} On these subjects I may refer my readers to chapter xii., p. 477, of *Diseases of the Male Organs of Generation*.

† In malignant disease the incision should be carried up much higher into the groin and the cord tied close to the internal ring. To prevent a hernia the layers should be sutured according to the directions given at p. 87.

required so as to ensure free and easy drainage.* In cases where the skin is involved by a growth, ulcerated by a hernia testis, or invaded by tubercle, two elliptical incisions should be made, well wide of the disease, and meeting above and below. The first incision having exposed the cord above, this is defined, and the scrotal tunics are quickly shelled off with the right hand, while the testis is still further protruded with the left.† The spermatic cord is now isolated as high as may be needful, the inguinal canal being carefully opened upon a director, if this is necessary to get above the disease. An aneurysm-needle, threaded with a double ligature of stout sterile catgut, is passed through the cord, the loop of the ligature cut, the needle withdrawn, and, the cord having been tied in two halves, the ends of



Castration through an inguinal incision for clean cases, and for growths which are not very large.

one ligature are cut short, while those of the other are tied round the whole cord to ensure that no vessel escapes. The cord is then clamped and divided below, but not too near to the ligatures, which may otherwise slip. If no bleeding occurs the ends of the ligature can be cut short, and the cord thus allowed to recede out of sight. The cord should not be divided before the ligature, for the latter is useful to keep the stump of the cord from receding before it is certain that the vessels have been efficiently controlled. The ligatures being thus embedded in the cord substance, there is no risk of their slipping, and if they be tied as tightly as possible (by looping the ligatures round two pairs of

* Kocher makes a transverse incision across the lower pole of the testis in septic cases and large tumours. The incision is parallel to most of the large scrotal vessels, and little bleeding occurs, and, above all, the drainage is excellent.

† There is often an adhesion below between the testis and the fundus of the scrotum (Fig. 297). This represents, according to some, the remains of the mesorchium.

scissors or forceps), there is no danger of after-suffering. Other methods consist in securing the vessels alone, singly by torsion, or by chromic gut, or by fixing the cord in the upper angle of the wound with a clamp. The mode of ligature above given is much more speedy and also, I am certain, perfectly efficient. Securing each vessel is tedious, as it is needful to make sure of every one, even when they are not enlarged, a condition not infrequent in growths. If any of the arteries are left unsecured, dangerous bleeding when the cord retracts upwards, calling for laying open of the canal, is very probable.

The cord having been secured and divided well above the disease, the mass is shelled out and removed. The wound is then examined in the case of a soft, rapid growth, and where a tubercular testis has threatened to fungate, any suspicious skin must be clipped away, and a sharp spoon freely used.

A few scrotal vessels, notably one in the septum, may require securing. The wound is then closed with salmon gut and horsehair, pains being taken to meet the tendency of the scrotal edges to invert.

Every precaution should be taken during and after the operation to promote rapid healing, especially in hospital practice. Patients who have to submit to castration are often reduced in health, and septic sinuses are often present, so that suppuration is apt to occur unless great care is taken to sterilise the parts as far as possible, and to provide efficient drainage; moreover, septic thrombosis may easily follow a wound made in a region so abounding in lymphatics and loose cellular tissue. Just before the operation the sinuses should be cauterised, so that they may not infect the wound.

In clean cases, and those with only moderate enlargement, I think very highly of Kocher's incision, which is made over the lower part of the inguinal canal and the external abdominal ring just below which the intercolumnar and the cremasteric fasciæ are divided and the cord exposed high up and ligatured and divided as described above. The canal must be opened in tuberculous and malignant disease. The testicle is then shelled out, all hæmorrhage stopped, the wound completely sewn up, and the dressings applied firmly to prevent any oozing. The advantages of Kocher's incision have been enumerated at p. 743.

ORCHIDOPEXY.

Indications for Operation.—(1) The co-existence of a hernia, which cannot be retained properly on account of the malplacement of the testis. In very nearly all the cases a potential hernial sac exists, so that a hernia may develop at any time in those in which the serous canal is sufficiently wide or distensible. Such a hernia is peculiarly apt to become strangulated on its first descent.

(2) Attacks of pain, either from twisting of a long mesorchium, which is commonly present, or from nipping at the external ring, or pressure within the canal. Strangulation and gangrene of the testicle may occur from twisting.

(3) Age. It is rarely of use to attempt to bring the testis down after puberty (*vide infra*). It is better to remove it after this age, when it causes trouble.

(4) The surgeon may decide to perform orchidopexy in a child even if the testis is a good deal smaller than the other was when it is known that the boy is intended for the army or navy later on.

(5) Retention in the canal or at the external ring, but not when the testis is within the abdomen.

The following account of this operation is extracted from that given in *Diseases of the Male Organs of Generation*.

One or two preliminary questions arise here: What is the value of the retained or ectopic testicle? At what age ought the operation to be performed? These may be answered together. It will be seen by reference to the account given at p. 45 *Diseases of Male Organs of Generation* of the condition of the retained or ectopic testicle, if nothing be done, that the following are certain: (a) that such a testicle ultimately becomes, and usually before adult life is reached, physiologically useless; (b) that, as some of the cases I have given show, during the early years of life the testicle, though ill developed, may be capable, under more natural surroundings, of becoming a useful organ; (c) that the period in which the testicle passes from a probably useful into a useless state must be an uncertain one, varying with the attacks of inflammation, &c. Most French surgeons have advised deferring the operation until the age of about 16, as up till this time a retained testicle may still descend. While this is true, I should strongly advocate resort to operation at an earlier date, a step which I have taken in the cases given below, on the following grounds: It must always be quite uncertain at what date structural changes marring the efficiency of a testicle have set in. These must depend on the number of recurrent inflammatory attacks, and children are certainly not exempt from these. Again, in cases complicated with a hernia, the longer an operation is deferred the more difficult will it be to ensure a radical cure. Moreover, a condition of this kind, interfering as it may do with activity and enjoyment of life, schooling, apprenticeship, &c., should be put right as soon as possible. Finally, if the testicle's growth and development are to be furthered by the transplantation—and this is one great object of the operation—it is surely more probable that this end will be secured by bringing the testicle into its natural home before puberty, that important epoch, and its consequent sexual changes have set in. I should prefer operating between the ages of 8 and 9, though in the case of the children of the poor, where time is of great importance, I should consider it quite justifiable to operate earlier, especially if there has been any attack of pain, or if a troublesome hernia co-exists. Before the age of 2 or 3 years the small size of the parts, their fragility as far as holding sutures go, and the difficulty of maintaining asepsis are contra-indications to operative interference.

The following account will be found to apply both to the case of a child and that of an adolescent.

The bowels having been well moved for a day or two before, the parts duly cleansed and shaved if needful, an incision is made with the external ring for its centre, as retention near this spot is the condition most frequently calling for operation. This incision can be prolonged upwards and downwards if needful, but needless weakening of the abdominal wall can often be avoided by dragging up or down the two angles of the wound with retractors, invaginating the scrotum, &c.

In cases of inguinal retention the testicle is reached after division of the external oblique and intercolumnar fascia.

The following points have now to be inquired into:—What is the arrangement of the peritonæum? Is the serous sac which surrounds the testicle continuous with and common to the peritoneal cavity or separated from it by obliteration of the funicular portion in part?*. The sac around the testicle or any prolongation upwards having been opened, the above question is settled. If the peritoneal process is open, it should be divided circularly with great care, so as to avoid the cord, a little above the testicle. While the lowest part, thus left, is fashioned by a few catgut sutures into a tunica vaginalis, the upper part is freed most carefully from its surroundings as high as the internal ring, where it is secured by ligature or torsion, as the surgeon prefers. If the peritoneal canal is found to be closed in the inguinal canal and above the testicle, it must be treated by the steps already given after its closed lower end has been found and the process freed. Care must always be taken to extirpate this process as far as possible and to close it thoroughly, as by this precaution an important obstruction is placed in the way of the testicle's remounting. Is a hernia present? If so, any adhesions to the testicle being separated, this is returned in the usual way. But the presence of a hernia must always, especially where there is any doubt as to the condition of the testicle, incline the surgeon to sacrifice the testicle and his hope of transplantation, and thus make sure of radically curing the far more important trouble. Will it be possible to bring the testicle satisfactorily down into the scrotum? How best will it be retained there? All adhesions should be divided as freely as possible, the position of the cord being first defined. Where the cord seems at first short, careful, sustained downward traction will often be of much assistance. When the testicle has been coaxed or pushed through the external ring, a bed must be prepared for it, if needful, with the finger in the scrotum. This is then invaginated with the tip of a finger, and the tissues thus presented sutured to the testicle with chromic gut. The suture should always be passed boldly, dipped well into the connective tissue of the invaginated fundus scroti on the one hand, and into the tunica albuginea of the testicle or the tail of the epididymis on the other. I prefer this method of invagination to that of passing the suture through the scrotum from without inwards, then next into the tunica albuginea, then out of the scrotum again, and tying the ends over a pad of gauze. Finally, when the testis is *in situ*, the internal oblique and conjoined tendons are sewn down to the upturned edge of Poupart's ligament in front of the cord. The cord is not dislocated, because that would make it too short to reach into the scrotum. The cord should be sutured to the pillars of the ring with fine catgut or silk, the vas and the spermatic artery also, if possible, being made out and inspected. Then this ring should be carefully closed with catgut, its pillars being first defined.

After the testicle has thus been fixed the wound is carefully dried, all bleeding arrested, the wound closed, and the dressings applied.

Writing in 1901, Mr. Jacobson wishes to state that his later experience tends to show that this operation is of very little value.

* In the great majority of cases the funicular process is patent, *i.e.*, a potential hernial sac exists, and this is one of the chief reasons for operating.

Supposing a scrotum to be present, everything depends on whether the cord is long enough to allow of the testis resting in the scrotum without any tension. As a rule to which there are very few exceptions, this is not the case. Out of seven cases he has had only one permanent and real success.

A boy, æt. 11, with iliac retention on the right side, had been refused admission to the Royal Navy. The scrotum was developed. At the operation a very unusual condition was found, viz., a loop of lax constituents of the cord where they met at the internal ring. The testis was easily brought down and secured in the scrotum, the layers of the abdominal wall being sutured much as in the radical cure of hernia. Two years later the boy was serving on the North American station.

On the other hand, Mr. Jacobson has known a testis fixed in the scrotum reascend a year and a half later, during the pyrexia of an attack of influenza.

The tendency of the testicle to retract and even to re-enter the inguinal canal is so great, that I have adopted the following method in several cases with gratifying results.* An inguinal incision is made and the canal is opened in all cases. The cremasteric and infundibuliform fasciæ are incised freely and separated from the cord. The funicular process of peritonæum is followed up beyond the internal ring, transfixed, ligatured, and divided as described at p. 77.

The cord and testis are then freed, and traction is made upon them, while any retaining bands of cremasteric and infundibuliform fasciæ are divided, scissors beginning antero-externally. If necessary, some of the veins are then divided between two pressure forceps and tied with catgut, more being divided until the testis can be easily placed in its natural position without any tension. The vas is rarely too short to allow this, so that it is not necessary to adopt Wood's method of separating the globus major from the testis and fixing the latter upside down in the scrotum. If the vas is not long enough, a little traction and gentle blunt dissection around it above the internal ring will liberate some of the pelvic part of the duct.

Care must be taken not to divide or injure the delicate connective tissues, vessels, and sympathetic nerves which surround the vas itself, lest atrophy of the testicle ensue. In two of my cases little else than the vas and the structures mentioned were left undivided, and yet the testis came to no harm beyond some transient orchitis. The internal oblique and conjoined tendons are then sewn down to the deep surface of Poupart's ligament. The cord, or what remains of it, is not dislocated, so that it may not be shortened. The wound in the external oblique is closed, care being taken to make quite a small external ring.

The fibrous tissues of the cord may be sutured to the margins of the ring in some cases. The parietal part of the tunica vaginalis is excised, so that the testicle may adhere to the scrotal tissues, instead of slipping up within a serous sac. A new bed is made for the testicle by

* No claim of originality is made for this operation, which is a composite one, based on the work of others. Dr. Bevan (*Journ. Amer. Med. Assoc.*, Sept. 19, 1903) describes a similar method, but he does not remove the parietal tunica vaginalis, nor does he take the same measures to prevent the reascend of the testis. Dowden (*Brit. Med. Journ.*, April 29, 1905) has removed the parietal tunica vaginalis and scraped the visceral layer.

means of a gloved* finger passed down into the scrotum. A stout catgut suture threaded on a long straight needle is passed from side to side through the part of the testicle which can be brought lowest, but well away from the epididymis and the vas deferens. The two ends of the thread are then brought out through the lower end of the new scrotal sac, by means of the long straight needle which is guided by the finger. Traction is made, upon both ends so as to bring the testis down to its normal position. The suture is tied loosely over a small piece of cyanide gauze placed outside the scrotum.

At the end of the operation the long ends are fastened to a circlet;† placed low down upon the opposite thigh, which is kept fixed to the bed.

The suture is only tied sufficiently tightly to keep the testicle and scrotum well down during the healing of the wound, and for about a week or ten days afterwards; cyanide powder is dusted over the scrotal punctures.

The after-treatment is very important, for, as the new connective tissues in the depth of the healed wound along the cord tend inevitably to contract, the testicle is drawn upward towards the groin. This slow but powerful force must be counteracted by daily traction for at least three or four months, one or both parents being carefully instructed how to do this and also impressed with the importance of it.

Mr. Corner (*Brit. Med. Journ.*, June 4, 1904) prefers replacement of the retained testis within the abdomen to orchidopexy, because he believes that the retained testis rarely becomes functional, and that the internal secretion of the organ is retained just as well after abdominal replacement. I do not agree with these views, but prefer to perform orchidopexy for suitable cases, for this is more likely to be followed by development of the testis, if undertaken well before the age of puberty. Experiments upon animals tend to show that the normal testis atrophies if replaced within the abdomen before the age of maturity.

* Gloves are used because absolute asepsis is essential for the success of the operation. Failure of asepsis may lead to sloughing of the testis.

† This is simpler and better than a wire scrotal cage.

CHAPTER XV.

OPERATIONS ON THE ANUS AND RECTUM.

**FISTULA.—HÆMORRHOIDS.—FISSURE.—PROLAPSUS.—
EXCISION OF THE RECTUM.—IMPERFORATE ANUS.—
ATRESIA ANI.—IMPERFECTLY DEVELOPED RECTUM.**

FISTULA.

Varieties.—As these have a very practical bearing upon the operation, they must be alluded to here.

i. *Complete.* ii. *Blind External.*—Here an external opening only exists, though in a considerable number of cases the internal opening is overlooked. iii. *Blind Internal.*—An opening through the mucous membrane is here the only one. This is the rarest, but an important variety, as, if overlooked, it is certain to be troublesome.

A discoloured dot or patch of skin sometimes marks the place where an external opening may occur. Mr. Lund (*Hunt. Lect.*, p. 88) relates a case in which a very chronic and slowly advancing blind internal fistula had excited, by its extreme end, just enough inflammatory thickening of the skin to imitate a keloid growth, for which it was at first mistaken.

Situation of Openings.—Both of these are usually within an inch, more often half an inch, of the anus. The internal one may be detected as a slight depression or papilla by the finger, or by the speculum, or, in obscurer cases, by the sigmoidoscope.

Horseshoe Fistulæ.—Here an external opening on either side communicates with a single internal one, often at the back. This is an uncommon, but an important variety, for if it is found necessary to cut through the sphincter ani at both sides, some loss of power is very likely to ensue. This risk should be explained to the patient, and the shallower fistula should be scraped, while the deeper is freely incised. If it is necessary to cut the sphincter on both sides, the knife should be employed on two distinct occasions, time being given for the first to heal.* It is better to make a free opening on one side, and to scrape and pack the other limb of the fistula from the opening.

Multiple Fistulæ.—This condition should always cause a suspicion of stricture, or extensive ulceration—*e.g.*, syphilitic, &c.

* Mr. Cripps (*Dis. of Rectum and Anus*, p. 165) shows that if, in women, the sphincter is cut through anteriorly where it decussates with the sphincter vaginæ, incontinence of fæces is very likely to take place.

Fistula with Tuberculosis.—Where a fistula presents an external opening with undermined, livid edges, where the tubera ischii stand out prominently from emaciated nates, and where the hair of the part is long and curled, tuberculosis is always to be suspected, even if no history of cough or hæmoptysis is given.

Question of Operating on Phthisical Patients.—While each case must be decided by itself, the following remarks may be useful:—

Where the phthisis is advanced, the cough incessant, the fistula multiple or branched, an operation is out of the question. On the other hand, where the physical signs are little marked, night sweats slight or absent, where the fistula interferes with the patient taking the all-essential exercise, where the power of repair is good, an operation is indicated.

In cases intermediate between the above, each one must be decided upon its own merits.

Before operating the surgeon should remember that repair is here often sluggish, the mental condition much depressed. He should do all he can to improve the general condition before and after the operation. And if this can be performed in sunny weather, or, better still, at the seaside, so that the patient can soon have fresh air in the recumbent position, so much the better.

Operation.—For a few days before the operation the diet should be restricted, and the bowels emptied by aperients. The hour of the operation should be so arranged as to give time for the enema, which should be given, to come away. The patient being under an anæsthetic, and either on his side with the knees well flexed, or in lithotomy position, the surgeon introduces lightly a fine Brodie's probe. In the case of a complete fistula, the internal opening being hit off (p. 758), the point of the probe is felt for by the finger and hooked out of the anus. If, after careful examination, the surgeon is satisfied that no internal opening exists, he makes one by finding the exact spot at which the coats of the bowel are most thinned, and thrusting the point of the probe through here.

In the case of a blind internal fistula the internal opening must be found with a speculum, and the probe, curved, passed from this so as to project beneath the skin. In every case the whole length of the sinus between skin and bowel must be completely laid open. When this has been done, very careful examination is made for other sinuses by the introduction of the probe, and by pressure with the finger, which squeezes out any discharge, and feels for indurated tracks. Wherever these run they must, if possible, be laid open. I have already (p. 758) alluded to the question of dividing the sphincter in two places. It is also important not to carry the incision higher into the bowel than is absolutely necessary; but free drainage must be provided by prolonging the incision far enough outwards into the ischio-rectal fossa. Every attempt, however, should be made, with the aid of a good light and forcible dilatation of the sphincter, to lay open every sinus with bistoury or scissors, extra care being taken, the higher the incision has to be carried, to arrest all bleeding with sterilised silk ligatures.

While the sinuses are being followed up, any old gristly tissue must be completely removed, all pyogenic or granulation tissue entirely scraped out, and every ill-nourished flap and tag of undermined skin cut away.

If any troublesome piles co-exist they should be tied and cut away at the same time (p. 761).

As a dressing I prefer a little twisted salicylic wool dusted with iodoform, as I find this adapts itself more easily to the different wounds. Less and less should be reapplied daily as granulations become established. After the first week little more is needed than daily cleansing of the wound with a dossil of cotton wool on a Playfair's probe. If the edges of the wound close too soon they should be separated with a probe from time to time, or any redundancy may be painted with cocaine and snipped away.*

Finally, no operation better exemplifies the truth of Mr. Curling's saying that the surgeon should be his own dresser.

Immediate Union of Fistulæ.—Mr. Reeves recommended this treatment some years ago (*Brit. Med. Journ.*, vol. i. 1887, p. 917). It certainly has the advantage of often shortening the treatment greatly,† and preventing loss of sphincter power, but at the risk of two dangers: (1) Sepsis. (2) The part within the bowel is sometimes difficult to suture satisfactorily, and may persist as a sinus later. The method may be tried in simple cases which do not extend far into the bowel.

Operation.—The anus having been well dilated, the fistula is laid open, thoroughly scraped out. Any skin or mucous membrane which is unhealthy or which will get between the edges of the wound must be snipped away, the bleeding stopped, the wound well irrigated with lot. hydr. perch. (1 in 4,000) and well dried out. It is then united in its whole extent by sutures of salmon-gut or sterilised silk. The sutures must underrun the wound, so that the depth of the latter may be efficiently closed. These are left in for a week or ten days. During this time the bowels, which have been previously (daily) thoroughly emptied, must not act. A glycerine or oil enema must prevent any passage of scybala and straining at the time of the first relief.

HÆMORRHOIDS.

Indications.

1. Continuance of hæmorrhage or discharge, and persistent liability to descent of piles in spite of judicious treatment. Prolapse of the hæmorrhoids may interfere with sitting, walking, and riding.
2. Repeated attacks of strangulation and thrombosis of the prolapsed piles.
3. Severe pain from associated fissure of the anus, or prolapse of the rectal mucosa.
4. Absence of albuminuria, diabetes, and hepatic (probably cardiac) disease.
5. Amenability on the part of the patient.

In Mr. Cripps's words (*loc. supra cit.*, p. 99), "the smallness of the risk should not lull the surgeon into a sense of absolute security, and he should spare no effort in ascertaining the general constitutional condition of his patients. . . . The amount of risk, slight as it is, should

* Another excellent dressing, later on, is tr. benz. co. or dilute nitric acid lotion 10 minims to 1 oz. The latter needs changing every four hours.

† It is right to add that the tediousness of the after-treatment is often due to the patient refusing to lie up, or to inefficient attention on the part of the surgeon himself.

be clearly laid before the patient or his friends. If a man is to have some grave operation performed, such as the removal of a cancer or the amputation of a limb, both he and his friends are well aware of the risk involved, and are accordingly prepared. It is, therefore, in the smaller operations, regarded by the surgeon and public as free from danger, that a fatality, when it does occur, becomes so tragic from being unexpected."

Operations.

Ligature and Excision.—Cautery.—Excision and Suture.—White-head's Operation.

1. **Ligature.**—I have placed this first, because, if properly used, it is a very easy, rapid, and good method. Here, as elsewhere, that surgeon will have the best results who has thoroughly familiarised himself with the details of one operation. The following appears to me to be a fair way of putting the merits of ligature and the other operations:—

1. In my opinion the ligature is more generally suited to all cases. Again, it can be more easily applied to piles high up than can the cautery. 2. No special instruments are needed. 3. A ligature applied is done once for all; the cautery may have to be reapplied more than once if bleeding follows when the clamp is unscrewed. 4. The risk of bleeding is less, and hence this method is especially advantageous in anæmic patients, and in those for whom it might be difficult to immediately obtain surgical aid (Allingham). 5. The ligature is free from the objections to the cautery in private practice—viz., the smell, and, unless a Paquelin's cautery is at hand, the cumbersome apparatus otherwise rarely used.

Operation.—The preparatory treatment is that given at p. 759. The patient being on his left side, or in the lithotomy position, the anus should always be dilated. This may be done by introducing, and then separating laterally, the two thumbs (Fig. 299), the pressure being steadily maintained so as not to rupture the mucous membrane. After a few minutes a sensation of yielding rather than of tearing is perceived. Another method is to introduce a large bi- or multi-valve vaginal speculum, and to withdraw this expanded.* When the sphincters are thoroughly dilated and the rectum is cleansed, the piles which lie lowest according to the patient's position† are drawn down with a vulsellum or tenaculum-forceps, and the surgeon with blunt-pointed scissors, curved on the flat, cuts a groove around the lower two-thirds of the pile, which is then separated for this distance from

FIG. 299.



Forcible dilatation of the sphincters.
(Esmarch and Kowalzig.)

* Eversion of the rectal mucous membrane by the finger in the vagina will often be most helpful in bringing piles within reach.

† This prevents the other hæmorrhoids being obscured with blood. Mr. Allingham advises that the smallest piles should be taken first, as there is a danger of these being overlooked and thus leading to a recurrence of the disorder.

the sub-mucous and muscular coats by blunt dissection. In the lower piles this groove should commence in the sulcus, which marks the junction of skin and mucous membrane close to the anus. The object of this deep groove is twofold: it forms a bed in which the ligature can be sunk tightly, and, above all, it leaves a very small pedicle of tissues to be strangled. The groove, moreover, can be cut without risk of hæmorrhage, as, however large the pile, its vessels enter it from above, running into its upper part just beneath the mucous membrane. The surgeon then ties round each pile, which is now still further dragged down, a ligature of sterilised silk, the strength of which he has previously tested. Sinking this into the groove, he tightens it up so as to embed his ligatures firmly, without cutting through the pedicle. About two-thirds of the pile are then cut away, enough being always left to ensure a safe hold for the ligature. In Allingham's *Diseases of the Rectum* (p. 146), the following most important practical point is insisted on. When the piles are separated from the bowel preparatory to applying the ligature, it is essential that the base to be ligatured should be as narrow as is consistent with safe securing of its blood-supply. For if many piles have to be tied, and their bases are left large and broad, when tied up they draw the mucous membrane together, and cause great narrowing of the rectum. In such a case it is almost impossible to introduce the finger, without force, beyond the parts tied. In other words, islets of untied mucous membrane, as wide as possible, should always be left between the tied piles. This will secure less pain, easier action of the bowels, and less risk of contraction. After every internal pile has been carefully treated in this way, the external ones are partly clipped away, care being taken not to encroach upon the junction of skin and mucous membrane, and not to remove subcutaneous tissue for fear of subsequent contraction. If any bleeding points still persist, they should now be tied. The ligatures are all cut short, and, lastly, the stumps of the piles, after thorough irrigation with lot. hydr. perch. (1—4,000) and rubbing in of iodoform powder, are returned. A morphia suppository is then introduced, strips of iodoform gauze wrung out of carbolic acid lotion applied, and firm pressure made with a T-bandage and the aid of a pad of salicylic wool. To hasten healing and prevent contraction, I generally close the longitudinal wound left after the excision of each pile by suturing it in a transverse direction with a continuous catgut suture. The ligature upon the stump of the hæmorrhoid is thus brought down to the anal margin. When many hæmorrhoids have to be removed this simple plan prevents any narrowing of the orifice.

ii. **Clamp and Cautery.**—This method has been perfected by Mr. H. Smith.* The preparatory treatment and position of the patient are those already given. The piles having been sufficiently protruded, and the anus forcibly dilated, they are drawn well down, one by one, with vulsellum forceps, and enclosed within the blades of the clamp, which is screwed tightly up. With scissors curved on the flat the pile is then so cut away as to leave a sufficient stump. This is then thoroughly

* Mr. H. Smith (*Syst. of Surg.*, vol. ii. p. 840) had almost entirely discarded the use of scissors, removing the clamped piles with heated cauteries instead. Three of these are figured.

seared down with a Paquelin's cautery, carefully kept at a dull red heat. If the iron sticks at any moment, owing to its cooling down, it should not be pulled away, but loosened by heating it a little. The clamp-screw is then slightly relaxed, and if any bleeding takes place it is at once tightened up, and the cautery reapplied. Every care must be taken to burn down the stump thoroughly at the first attempt, for if this fail, and oozing take place, it is not easy to stop the bleeding, from the tendency of the stump to slip through the slackened clamp. The piles having been successively dealt with in this way, the stumps are smeared with iodoform ointment and pushed well up with a finger coated with the same.

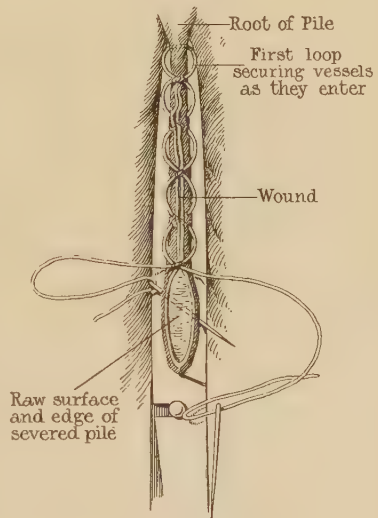
This method is thought by some to secure more rapid healing with less pain than the ligature. This, however true of the old methods, does not hold good when the piles are freely detached and the ligature tied with the precautions already given. The clamp is less easily manipulated in the rectum. It is a special instrument not always at hand, and the smell entailed by the cautery is most unpleasant. The surgeon who uses it must be extremely careful to keep his seared surfaces as small as possible, and by no means to entrench upon the skin. It is well known how slowly, how painfully, and with what a tendency to contraction burns heal. The cautery is a troublesome instrument to carry about, and not infrequently gets out of working order just when it is most wanted, and for no very obvious reason. I greatly prefer to use the more exact, simple, and comparatively painless excision and suture method. The cautery ensures asepsis at the time of the operation, and hence it was a comparatively safe method before the days of aseptic operations, but the slough must separate by ulceration, which makes the convalescence of the patient more painful and uncertain with this than any other method used at the present day.

iii. **Excision and Crushing.** Injection with chemicals—and application of acids are no longer necessary, and have rightly given way to more accurate and more radical methods.

iv. **The Operations of Robert Jones and Thelwall Thomas.**—Very similar operations were independently devised and described by these two surgeons. Mr. Robert Jones published the following account in 1893 (*Prov. Med. Journ.*, 1893, p. 400):—

"The hæmorrhoid is placed within the clamp (Smith's by preference) and cut off, leaving about an eighth of an inch of pedicle. This cut edge is sewed with a catgut suture, the clamp removed, and the operation is complete. The best plan is to take a piece of catgut about eighteen inches long, with a needle at each end. One needle is passed

FIG. 300.

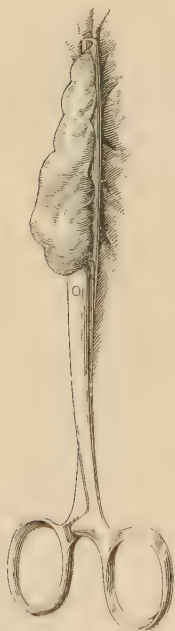


The clamp and suture method.
(After Robert Jones.)

through the upper end of the pedicle, and a first knot is tied; then the needles are passed from left to right and right to left, and each time they cross the pedicle they are tied. The diagrams help to illustrate this (Fig. 300). Except in the case of friable granular hæmorrhoids, I shall not use the cautery again; and I am inclined to believe that stitching the pedicle is more in accord with one's surgical instinct than burning it, which of necessity means the subsequent separation of a slough."

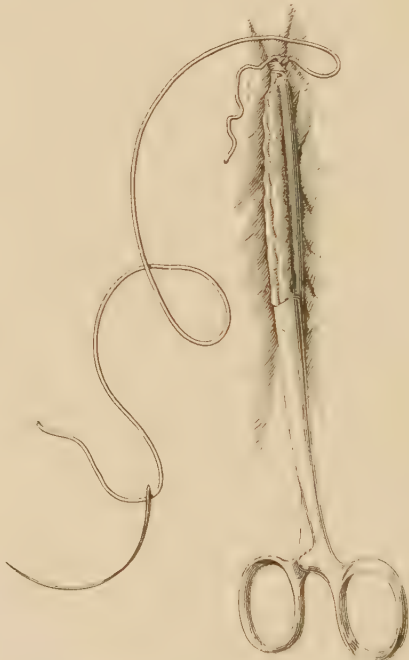
Mr. Jones now uses narrow-bladed special clamp forceps, one of the blades of which is spiked to prevent the instrument slipping.

FIG. 301.



The pile is clamped.
(After Mitchell, *Brit. Med. Journ.*)

FIG. 302.



The catgut suture is begun and tied just above the upper end of the stump, thus securing the main artery. (After Mitchell.)

Mr. Thelwall Thomas (*Brit. Med. Journ.*, Nov. 26, 1898) gave the following description of the operation, which he had then performed for several years.

Operation.—The sphincter having been stretched, "a large pile is seized by artery forceps, and its base clamped, the clamp being always put on in the long axis of the bowel. I have most frequently used Smith's clamp, but a dressing forceps with a catch will do quite as well.* The bulk of the pile is cut away, leaving a small stump standing off the clamp. The treatment of this is the essential feature of the

* Later Mr. Thomas says that he has found Doyen's broad ligament clamp (small size) superior to all others. These are apt to slip, however.

operation. A piece of catgut, not too fine, about a foot in length, with a domestic needle at each end, is used for a suture. Commencing at the top end of the stump, one needle is passed through, and the catgut follows until there is one half the length of the suture on each side, with its own needle attached. A reef knot is tied on the stump, and the needle which is on the right side is brought over to the left and passed through the stump lower down and back again to the right. The needle which is on the left is taken over to the right and passed through the stump back to the left immediately adjoining the previous one. A reef knot is again made, and so on to the end of the stump, making

FIG. 303.



A continuous suture is rapidly applied round the clamp with a curved needle.
(After Mitchell.)

FIG. 304.



The clamp is removed, the suture tightened and knotted.
(After Mitchell.)

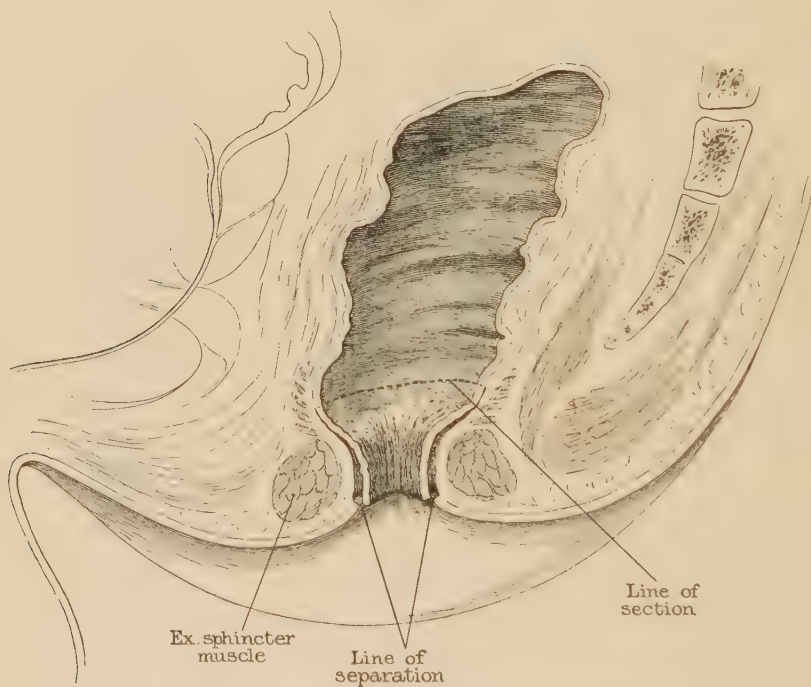
five or six crossings to the inch. This method of suture brings the cut edges of the mucous membrane tightly together, and its advantage over a simple continuous suture is apparent, each cross and knot making each segment independent of the next. The clamp is slackened, and occasionally, though rarely, it may be necessary to tie a small vessel at the top end of the stump, particularly if a cross-acting clamp is used. All the internal piles are thus treated." The great advantages claimed for the operation are (1) that primary union is obtained, and so convalescence is more rapid; (2) that reactionary and secondary hæmorrhage is prevented.

Mr. Thomas has performed 45 operations in this way, with extremely satisfactory results. The bowels were opened on the fifth

day, and full diet was given on the eighth day. No pain was complained of, and none had any hæmorrhage or inflammation. The average stay in hospital of the 45 cases was 8·8 days.*

Mr. A. B. Mitchell, of Belfast (*Brit. Med. Journ.*, Feb. 28, 1903), also uses a continuous catgut suture, but he only knots it twice, just beyond the extremities of the wound. The first turn secures the main artery before it enters the stump. The tail thread is left long, and the continuous suture is rapidly passed round the clamp, so that the thread gets a wider grip and is more hæmostatic. The clamp is withdrawn when the suture has been placed, and traction is made upon both ends

FIG. 305.



Whitehead's operation. A tube of mucous membrane is isolated.

of the thread, so that accurate apposition may be obtained without puckering of the wound. The lower knot is then tied, and the upper and lower tail ends are cut off (Figs. 301 to 304).

Dr. L. S. Pilcher, of New York (*Ann. of Surg.*, 1906, vol. xlv. p. 275), describes and figures an operation almost identical with that of Mitchell, except that he does not apply the clamp forceps until he has severed the redundant perianal skin below each pile and has separated the lower part of the latter from the sphincter. He removes more of the skin than most surgeons do. There is no great advantage in doing this.

The excision and suture method with the aid of clamps is the most

* This is certainly too short. The patient should be kept recumbent for a fortnight.

suitable one for most cases of piles ; but it is not applicable to the very worst, for which Whitehead's operation is to be preferred. The operation is a very safe and comparatively easy one, and most surgeons, especially those without much experience, will get far better results from it than from the more severe operation of Mr. Whitehead. When it is used for cases of moderate degree of severity (the majority) the results are excellent, and recurrence, although possible, is quite rare. On the other hand, if it is attempted for extensive disease encircling the lower part of the bowel, the removal is bound to be either incomplete or so extensive as to narrow the orifice when the sutures are tied. Recurrence is therefore likely to follow in such cases, although the removal of many strips of mucosa tends to brace up the remainder. It is, therefore, better to perform Whitehead's operation for bad cases in order to be certain of a permanent success.

v. Whitehead's Operation of Excision of the whole "Pile-bearing" Area.*—This extensive operation is intended to bring about a radical cure, its object being not only to remove any existing piles, but also all the mucous membrane in the lowest part of the rectum, which is the seat of piles, owing to the tendency of its veins to become dilated. Though Mr. Whitehead has performed this operation in 300 cases without a fatal result or any drawback, I cannot but consider it needlessly extensive and severe, especially in patients of middle life, and in a part which cannot always be kept sweet. The operation by ligature, or by clamp and cautery, carefully performed, gives most excellent results, and, in answer to Mr. Whitehead's argument that as long as this diseased area is left to reproduce piles over and over again no permanent cure can be expected, I may say that I have always found that, after one of the above operations has been properly carried out, the patient can easily prevent any recurrence by attention to common-sense details in daily life. Finally, I know of one case, in a young, healthy patient, fatal from blood-poisoning.

The following criticism (Allingham, *Diseases of the Rectum*, p. 139) appears to me soundly based: "Mr. Whitehead terms his operation simple. Simple it may be, but difficult to perform, for with the anus rugose and elastic as it is, even after dilatation of the sphincters, it is not at all easy to separate the mucous membrane from the skin. The time required for the operation is an objection ; this process takes on an average at least thirty minutes, where a skilled surgeon can operate with the ligature in less than five minutes. The hæmorrhage by this method far exceeds the amount lost when the ligature is used, and this is of great importance in those patients who have already lost much blood from their piles. . . . Two or three days after the operation the parts not infrequently become swollen, and the mucous membrane then tears through the ligatures and retracts away from the skin. This leaves a large granulating surface which may occupy the entire circumference of the bowel, and cause troublesome contraction."

Stricture of the rectum has occasionally followed Whitehead's operation, even when it has been performed by the ablest surgeons. Severe hæmorrhage has also occurred when the stitches have given way and

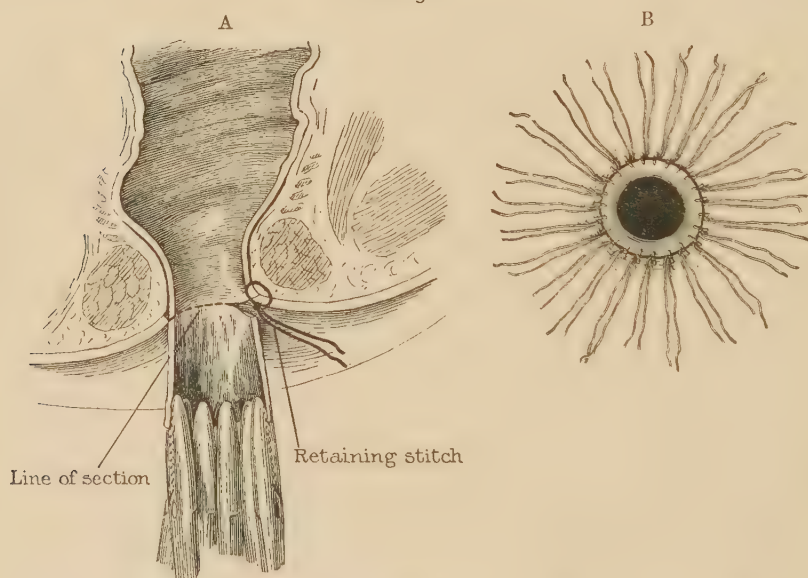
* *Brit. Med. Journ.*, Feb. 26, 1887.

the rectal mucous membrane has retracted. Both these catastrophes should be rare if the suturing be done with great care, but even the best work does not always prevent the stitches tearing out in malnourished and anæmic patients. It is fairly common for some temporary loss of anal sensation and control to follow Whitehead's operation.

Careless operators or those without a knowledge of anatomy have even damaged the sphincter ani in separating the mucous membrane. I fear that a good many bad and imperfect results have not been published.

Despite these occasional accidents, the operation is a good one when

FIG. 306.



Whitehead's operation. The pile-bearing tube is drawn down with pressure-forceps and gradually cut away. After each snick with the scissors a retaining stitch is inserted (A). B shows the operation completed, the ends of the silk sutures being left long and held in forceps until the circle is completed, and any secondary sutures inserted between the primary ones, if necessary.

skillfully performed for suitable cases; but it is certainly not one to be undertaken lightly by surgeons of little experience. It is especially indicated for extensive and confluent hæmorrhoidal disease with laxity of the anus and some prolapse of the mucosa and chronic inflammation. Such cases are not suitable for less severe and easier methods. Debilitated and very anæmic patients are not favourable subjects for it.

Operation.—An aperient is given two nights before the operation, and another one early on the evening before the operation, so that the bowels may be well cleared out before the time fixed for the operation. If this plan is adopted an enema is not required in the majority of cases, but if one is given it must be well administered, and thoroughly evacuated before the time of the operation. There is nothing more

annoying and dangerous than an unsatisfactory enema which causes the bowels to act during the operation.

The sphincters having been thoroughly dilated, and the rectum well cleansed, a temporary plug of gauze is inserted above the field of operation to prevent any possible contamination with fæces. A ligature is attached to the gauze, so that the latter may be easily withdrawn at the end of the operation. The hæmorrhoidal area of mucous membrane is made to prolapse, and the prominent edge is seized with four long hæmostatic forceps, placed at equal distances from each other round the circle. Traction is made with the forceps, while the mucous membrane is divided with blunt-pointed scissors a little above the white line,* where the skin and mucosa meet. The mucous membrane is then dissected up with forceps and scissors, from off the external and in part the internal sphincter, till the whole of the pile-producing area of mucous membrane can be pulled down and drawn outside the anus. It is then cut away, bit by bit,† transversely at its still attached upper border, each portion when divided being at once attached to the cut skin with sterilised silk sutures. In this way the diseased area is removed as a complete ring of mucous membrane.

It is of vital importance to use plenty of sutures both for controlling hæmorrhage, and also for securing firm and accurate apposition. Each suture must also take an ample bite of the rectal mucosa, so that it may not tear out prematurely, and for the same reason the threads must not be too fine.

Bleeding is at once controlled by finger pressure, until another suture is introduced to arrest it. It is not necessary to ligature any vessels. Before completing the operation the entire circular wound is examined, and a stitch is inserted here and there between the primary sutures wherever the apposition is not perfect or any bleeding occurs. This examination is facilitated by traction upon each primary suture in turn. The ends are then cut short, and the temporary plug is withdrawn. A morphia suppository (gr. $\frac{1}{4}$ or $\frac{1}{2}$) is introduced into the rectum. The centre of a large piece of antiseptic gauze is now pushed well into the rectum, and the saccular part of it within the bowel is filled with strips of gauze. Gentle traction is then made upon the enveloping layer, to bring the pear-shaped plug down towards the sphincter. The plug serves to prevent fæces coming down to the suture line. To keep the rectum at rest, no solid food is given for four days; hot drinks and milk are also avoided, for the same reason. On the fourth day the rectal plug is removed under nitrous oxide anæsthesia, and an ounce of castor oil is given to secure a free and fluid evacuation. Allingham's pill also acts well (Pil. Hydrarg. gr. ii., Pil. Colocynth et Hyos. ad gr. viii.). When the bowels have been opened, the diet is rapidly increased to full. A daily evacuation of the rectum is essential, otherwise hard scybala soon form and give rise to much trouble and pain. The sutures are allowed to come away spontaneously. The patient is kept in bed for a week or nine days, and is allowed to walk out at the end of a fortnight. The anus is sprayed with boracic lotion several times daily, and is thus kept quite clean.

* The "white line" of Mr. Hilton (*Rest and Pain*, p. 289, Figs. 51 and 52).

† So as to diminish the hæmorrhage, which would otherwise be free at this stage.

The stream of warm lotion is less painful than even the gentlest swabbing.

Causes of Failure and Trouble after Operations for Hæmorrhoids.

—1. *Hæmorrhage*.—This will be extremely rare if the precautions which have been mentioned under each operation are carefully observed, but it is most likely to follow Whitehead's operation, owing to the tearing out of stitches. It used to be not uncommon after the clamp and cautery. It is very rare indeed after the ligature and suture methods. The conditions under which this complication may occur are cases of long-standing piles or prolapsus in weakly subjects, cases where the tissues are very friable, where the patient insists on getting out of bed to pass water, or where he strains very much at the first action of the bowels. If the surgeon be called upon to meet it, the best means is to catch the vessels with Spencer Wells's forceps, and tie them with silk. Failing this, the centre of a large piece of antiseptic gauze is pushed well into the rectum, and the sacular part of it within the bowel is then filled with gauze strips until a pear-shaped plug is formed. Traction upon the sides of the sac of gauze brings the plug down against the sphincter or anal constriction, and effectually controls the hæmorrhage. The strips of gauze are easily removed. Styptics such as $\frac{1}{2000}$ of adrenalin chloride may be applied on the gauze. The plug should be left in as long as possible, the patient being kept under the influence of morphia if necessary.

2. *Tedious Ulceration*.—This is often due to the patients getting up too soon or the use of the clamp and cautery or the ligature method without any sutures for approximation of the mucous edges. The patients should remain in bed a week or ten days, and then be content to pass another week or ten days upon the sofa.

3. *Septic Troubles*.—These may follow from want of care in performing the operation, especially in cleansing the rectum very thoroughly.

4. *Contraction*.—This is usually stated to be only likely to occur when in cutting away piles, especially external ones, the junction of skin and mucous membrane is trenched upon. But the fact is that where many piles have had to be removed, where islands of mucous membrane (p. 762) have not been left between them, the ulcerated surfaces thus tending to coalesce, contraction of the surface as it cicatrises is very likely indeed to lead to some narrowing of the lumen of the gut. This must always be prevented by the early passage of the finger of the surgeon in charge, this being repeated daily if any tendency to contraction is found. Where a stricture, generally about one inch and a half from the anus, has been allowed to form, the patient's condition is a most vexatious one, though it will always yield to the use of bougies, aided, if need be, by nicking of the contraction.

A serious stricture is most likely to follow Whitehead's operation, from retraction of the rectal mucosa due to the stitches tearing out. This may be due to the use of too few or too fine threads, or to the insufficiency of the bite taken by each suture.

5. Loss of anal sensation. 6. Loss of perfect control. These most often follow Whitehead's operation.

7. Abscess. 8. Fistulæ. 9. Bubo. 10. Pelvic suppuration. These four are given by Mr. Allingham (*loc. supra cit.*, p. 163) as sequelæ in unhealthy patients, especially if the healing has been accompanied by pro-

longed suppuration. The antiseptic surgery of the present day should almost prevent this.

FISSURE.*—ULCER.

The operative treatment of these is so simple and so eminently successful, that it should be resorted to early.

A. Operation by Incision.—The preparatory treatment and the position of the patient are the same as those already given. The division of the ulcer may be performed in one of two ways: (a) from without, (b) from within, the rectum.

(a) *From without.*—Here the ulcer, being fully exposed with a speculum—and the one which bears Mr. Hilton's name, with a movable valve, will be found the best—a small sharp-pointed bistoury is inserted a little beneath the base of the ulcer, and its point made to protrude in the bowel above it; the parts are then divided from without inwards through the centre of the ulcer.

(b) *From within.*—Here, the ulcer being also exposed either by stretching the parts with two fingers or with a speculum, a straight blunt-pointed bistoury is drawn across the whole of the sore through its centre, going deep enough to divide about a third of the fibres of the external sphincter. Mr. Curling (*Diseases of the Rectum*, p. 12) has drawn attention to an important point here, and that is, that the fibres of the muscle at the extremity of the ulcer near the verge of the anus should be divided rather more freely than those above, so as to avoid any ridge or shelf on which the fæces would lodge.

There is usually no hæmorrhage to speak of, and the whole operation is so simple that it may be performed after an injection of cocaine, or with nitrous oxide gas, unless anything else—*e.g.*, attention to piles—is required. I prefer, however, to operate with ether or the A.C.E. mixture.

Of the two methods, I generally make use of the first, following Mr. Hilton. I consider it the more certain, and have never known of anything like incontinence in the nine cases in which I have used it. The second is rather the slighter operation, and also gives good results.

The position of these usually club-shaped ulcers is posterior. If one is met with anteriorly in a woman, it would be wiser to try the application of acids, or the actual cautery. See footnote, p. 758.

The surgeon must be careful, when examining into the amount of repair a week or two later, not to do any damage if a speculum is employed.

B. Operation by Dilatation of the Sphincter.—This is not only rough, but uncertain, and should not be employed.

C. Operation by Excision and Suture.—To hasten healing, and make it more certain, the whole ulcer, whose base and margins are often firm from long-continued chronic inflammation, is excised down to the muscle fibres, leaving healthy tissues, which are sewn carefully with a continuous catgut suture. Each stitch must run deep to the

* This condition, often called a fissure, nearly always amounts to an ulcer when it is carefully examined and the parts unfolded. It is often formed by the tearing down of one of the pouches placed at the junction of the anus and rectum. The strip of mucous membrane which is torn down to the anal margin is often called the sentinel pile (Ball).

apex of the V-shaped wound, so that accurate apposition of the depth, as well as of the mucous edges, is obtained. If only the mucous edges are joined a fistula may result and time be lost instead of saved by adopting excision instead of incision. Any sentinel pile is also excised.

PROLAPSUS.

Indications.—Failure of previous treatment. Large size and long duration of the prolapsus. Altered condition of the mucous membrane—viz., thickening or ulceration, the latter giving rise to hæmorrhage. Incontinence of fæces, especially when fluid, or of flatus. It is very rare for any operation to be required in children, for care in dieting, enforced rest in the horizontal position, and proper attention to the bowels nearly always suffice. Threadworms, rectal polypi, phimosis, or vesical stone must be sought for and treated if necessary.

Operations.

Acid.—**Cautery.**—**Excision.**—**Sub-mucous Injection of Paraffin.**

1. **Acid.**—Of these I prefer the acid nitrate of mercury. This method is especially applicable to the obstinate cases of prolapsus in children, where the bowel is constantly down. Though, if the application is made properly, only a sensation of burning is complained of, an anæsthetic should always be given. The patient being in the lithotomy position, or on one side, the prolapsus is carefully dried of all mucus, and the surgeon rubs in the acid with the aid of a glass rod or pointed pieces of wood, the adjacent skin being protected with vaseline.

Care must be taken not to rub in the acid too long or too vigorously, for if the inflammatory process set up affects deeply the sub-mucous tissue, a most troublesome stricture may readily result.

It is well to warn the patients that a second application may be required in severe cases.

The after-treatment is that given below.

2. **Cautery.**—In severer cases, or where the acid has failed, the following will be found efficient. The position of the patient is as for pile operations, but it is best to apply the cautery to the bowel *in situ*, though this may be used when the bowel is prolapsed.

Thus, the patient being in lithotomy position, and a duckbill-speculum introduced and held in contact with the anterior wall of the rectum, the blade of a thermo-cautery is drawn edgeways along the lower three or four inches of the opposite surface of the gut. The speculum being shifted, the anterior and lateral aspects are similarly treated in severe cases.

Care must be taken not to go *through* the mucous membrane, or septic mischief and sloughing may be set up in the cellular tissue beneath.

3. **Excision.**—In severe cases in adults, when other methods have failed, this method should be resorted to, but even with the improvements of the present day there must always be a difficulty in keeping wounds here aseptic. If the precautions mentioned at pp. 768, 769 are observed, the risk of infection from the fæces is greatly diminished, but not entirely abolished. Either portions of mucous membrane only, or, in very severe and intractable cases, the whole prolapse, may be removed.

i. Excision of Mucous Membrane.

The patient being in lithotomy position, the prolapsus reduced, and the parts exposed by a duckbill-speculum, two or more elliptical pieces of mucous membrane are removed by pinching them up with vulsellum-forceps and cutting them away with a very sharp scalpel or scissors. Any bleeding vessels are then tied with chromic gut, and the edges of the wound united by catgut sutures. Iodoform is then carefully dusted on, and the parts smeared with an ointment of the same.

The insertion of sutures has the advantage of preventing hæmorrhage, and hastening the cure. In some cases the prolapsed mucous membrane is excised much as in Whitehead's operation for hæmorrhoids.

ii. Complete Removal of the Prolapse.

Although a more certain cure, this method is much more severe than those already described, and owing to the risk of the operation, should be reserved for cases in which other methods of treatment have failed, the prolapse has become irreducible, or when gangrene threatens.

The operation essentially consists of amputation of the prolapsed bowel, with suture of the divided edges at the margin of the anus.

It must be remembered, however, that a pouch of peritonæum may be present in front between the layers of the prolapsed bowel, and that, in certain cases, a herniated loop of intestine may lie within this pouch. Owing to the vascularity of the parts, considerable hæmorrhage may occur, and, with a view to controlling this, several operators have advised constriction of the base of the prolapse, either by means of specially devised clamps, or by an elastic ligature, applied above transfixing pins, before commencing its removal. The objection to this is, however, the possibility of damage to a knuckle of small intestine lying in a prolapsed peritonæal pouch. Moreover, the hæmorrhage may be satisfactorily dealt with by dividing only small portions of tissue at a time and applying catgut ligatures to the vessels in each portion as they are divided.

The details of the operation have been varied by many surgeons, one of the best methods being undoubtedly that of Mikulicz, which is described as follows by Cumston, of Boston (*Ann. of Surg.*, March, 1900), in a paper containing much valuable information:

"Mikulicz first cuts through the outer intestinal tube in its anterior circumference by cutting the tissues layer after layer, catching up each bleeding vessel as it appears, and ligating it with fine catgut. As soon as the peritonæal pouch has been opened, its interior is examined for the presence of small intestine. The peritonæal cavity is then closed by a running suture. The anterior aspect of the internal intestinal tube is cut through, little by little, until it is opened, and then both intestinal tubes are united by deep silk sutures along the entire line of the incision.

"The posterior circumference of the prolapse is treated in absolutely the same way, both intestinal ends being united by means of silk sutures, and thus the resection is completed."

4. In some cases, when the anus is patulous or the sphincter paralysed or damaged, some form of plastic operation may be performed, with the object of narrowing the orifice and, if possible, of restoring the

function of a divided sphincter also. Thus Mayo Robson (*Practitioner*, February, 1903) makes a semilunar incision parallel with the anterior margin of the anus. The wound is deepened for about half an inch and then sutured, so that it runs antero-posteriorly. This narrows the anal orifice very considerably, and tightens the sphincter. The incision may be so placed that a divided sphincter may be reconstructed. The wound is entirely external to the bowel, and in this respect this method is better than excision of wedges from the anal margin.

5. In some cases, with paralysed or lost sphincter; sub-mucous injection of paraffin may be found to be of value as in Mr. Stephen Paget's case (*Brit. Med. Journ.*, February 14, 1903) of prolapse following perinæal excision of the rectum.

Mr. Paget (*Lancet*, 1903, vol. i., p. 1354) thus expresses his views upon this subject:—

“I have had only three cases, but the results were so good that the method certainly deserves consideration. My patients were all over 60 years old. One had prolapse of the bowel after excision of the rectum for cancer, one had prolapse of the bowel of twenty-two years' duration, and one had suffered for twenty-eight years from prolapse of the uterus. I need not say what an amount of misery these three old people represent; and, to my amazement, they have all of them been cured. It is too soon to be sure that they will not need another injection later; but for the present there they are, wholly free from what had seemed incurable troubles. The paraffin, in these cases, must be injected immediately under the mucous membrane of the prolapse, so as to raise and to thicken and to stiffen it and to narrow the passage through which the prolapse comes down. With a prolapse of the bowel I think it is a good plan to take a fold of the prolapse between one's finger and thumb, and to endeavour to make two or three well-defined round masses or hummocks of paraffin which shall form a sort of valve or partial stricture just inside the anus. In a bad case you may have to inject the paraffin at diverse levels and for some distance above the anus. . . . The paraffin must be kept away from the bladder and ureter, and injected mostly under the posterior and lateral folds of the everted mucous membrane.”

Mr. Burgess (*Lancet*, 1904, vol. ii., p. 759) has used this method in 18 cases of prolapse of the rectum, and in one of these there was severe incontinence. He thus describes his method of injecting the paraffin:—

“The paraffin I use has a melting point of 111° , and can be obtained sterilised in small bottles. It is kept melted by placing the bottle in a bath of water at a temperature of about 120° F. The syringe has its barrel covered with rubber to retain the heat longer, but I use no special means to keep the needle hot. The syringe also is placed in the hot water bath for a few minutes, is then filled with the melted paraffin, and replaced in the bath until the moment it is required to be used. The syringe and paraffin can be obtained from Mr. Frank Rogers, of 327, Oxford Street, London, W.

“The following is the technique of the operation which I now perform. The patient is anaesthetised and placed in the lithotomy position, and the prolapse is drawn outwards to the fullest possible extent. I next seize the apex of the prolapse with artery forceps at three points equidistant along its circumference, so selected that two forceps will be

placed anteriorly and the third in the posterior median line. By gentle traction on these forceps the assistant then raises the mucous membrane into three ridges, forming an equilateral triangle. The needle of the syringe is inserted in turn into the middle of each side of this triangle, from two to three cubic centimetres of paraffin being introduced on each occasion. As this solidifies it will be found that the mucous membrane has become bulged inwards, encroaching on the lumen of the bowel and converting it into a more or less triradiate slit. The forceps are removed, the apex of the prolapse is reduced, and the mucous membrane is again seized with forceps about one and a half inches from the original apex, the forceps being again placed equidistantly, but this time two are placed posteriorly and the third in the anterior median line. The mucous membrane is again raised into ridges by gentle traction on the forceps, and the needle is inserted midway along each ridge as before, with the result that the lumen of the bowel is again converted into a triradiate slit, the radii, however, corresponding to the intervals between the radii of the tier above. This portion of the prolapse is now reduced, and the forceps are reapplied, this time two being anterior and one posterior, and the process is repeated until the anus is reached. As a rule three tiers are sufficient, but in a very long prolapse more may safely be introduced. In order that any straining on the part of the patient may not cause the prolapse to redescend before the paraffin has firmly set I insert a stout silkworm gut suture through the buttocks on either side and tie it firmly over a pad of gauze placed over the anal orifice. This suture is removed at the end of twenty-four hours. No special after-treatment is required. The patient is kept in bed for four or five days. The bowels have usually been allowed to act spontaneously.

Results.—Of the 18 cases the ages ranged from 3 to 48 years and the size of the prolapse from one and a half to five inches in length. In all of them previously to the operation the prolapse descended with almost every action of the bowels and remained down until replaced. Two were associated with excoriation and ulceration of the mucous membrane. Two had been previously treated by the method of linear cauterisation without success, and two had recurred even after the excision of the lower part of the rectum. The result of the operation has been extremely satisfactory in all the cases, not a single instance of redescend of the prolapse having occurred. One patient left the hospital at the end of a fortnight, but the remainder have all been under observation for at least two months, and several for a much longer period. I have examined the rectum digitally at periods of from one day to six months after the operation, and the paraffin masses can readily be distinguished, feeling like nodules of cartilage or dense fibrous tissue. They do not appear to alter this character within the period specified, at any rate to any appreciable extent.

“The action of the paraffin must, in the first instance, be a purely mechanical one, since the good results follow immediately upon its setting and cannot therefore depend upon any vital phenomena. During the descent of a rectal prolapse it may be observed that the process is a progressive eversion of the rectal mucosa, beginning at the muco-cutaneous junction and extending upwards. For this to occur there must be a certain degree of flexibility of the rectal wall, which is,

of course, materially impaired when it is infiltrated with paraffin. Moreover, the presence of the latter very considerably narrows the space through which the prolapse has previously descended, and in fact, if the technique is carried out according to the method I have described, the lumen of the bowel is converted into two or more triradiate slits so superimposed that the radii do not correspond. This valvular arrangement offers, I believe, a very efficient obstacle to the redescend of the prolapse."

Sepsis and embolism have followed the injection of paraffin; but the danger of these accidents is not very great if proper precautions be taken.

Comparing this with other methods of healing rectal prolapse, Mr. Burgess claims the following advantages:—(1) "It is a simpler procedure, excepting, perhaps, linear cauterisation, and can be more rapidly performed; (2) it entails practically no risk to life; (3) no prolonged after-treatment is required, merely keeping the patient in bed for a few days; (4) the benefit obtained is apparent immediately the paraffin has set, and does not depend upon any subsequent vital phenomena, nor does it make any demand upon the reparative powers of the patient; (5) it offers a much greater probability of a permanent cure; and even should it fail the patient's condition is no worse than before, and the procedure may be repeated subsequently."

It is uncertain whether this treatment will find a permanent place in surgery of prolapse of the rectum, for the recorded cases had not been observed for a sufficient length of time at the date of publication to justify us in drawing reliable conclusions from them. Mr. Stephen Paget's cases had only been observed for a few months and, in one of them Mayo Robson's plastic operation was also performed at the same time. Mr. Burgess's 18 cases had all been treated within fifteen months of the publication of his paper.

I cannot agree that the treatment is very simple, nor has it been proved that the results are more permanent, although the published results are good as far as they go. Some of the patients treated in this way might have got well with conservative treatment, for at least some of them were children, who rarely require any operation for prolapse; and it must be a rare thing for one surgeon to see 18 cases of prolapse requiring operation within fifteen months. It is more likely that this method will be found useful when plastic operations are unsuitable or have failed, and when the sphincter is absent or paralysed. Whether the paraffin will or will not sooner or later give rise to any septic troubles when retained in the rectal wall remains to be seen.

After-treatment.—After any operation for prolapsus the patient must rest for three weeks on the sofa to allow of firm consolidation and cicatrization taking place. Light diet alone should be allowed at first, and the bowels should at first be allowed to act only every three days, and, if possible, while the patient is on his side.

EXCISION OF THE RECTUM.*

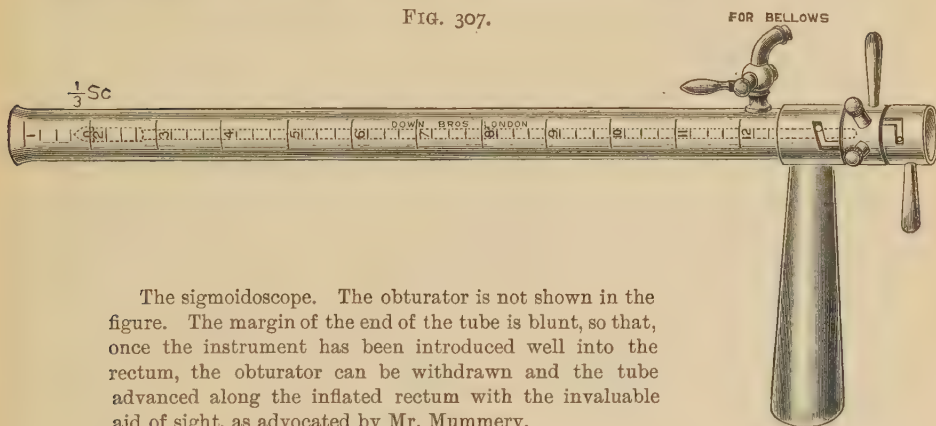
Partial excision would be usually a more correct term in the majority of cases, but as by the sacral route, and by the combined methods, the rectum has been removed up to the sigmoid flexure, I retain this heading. Under it the following operations will be considered: (i.) **Excision from the perinæum.** (ii.) **Kraske's operation and its**

* The rectum is here regarded as starting at the left sacro-iliac synchondrosis.

modifications. (iii.) Excision by the vagina. (iv.) Excision by abdominal section. (v.) Excision by the combined methods, especially the (a) abdomino-perineal and (b) abdomino-anal.

Indications. Suitable Cases.—1. Malignant disease of anus—*e.g.*, papillomata or a neglected fistula, or condylomata becoming epitheliomatous. 2. Rarely non-malignant stricture and ulceration may be treated in this way instead of by dilatation, but only in cases where extensive ulceration exists with multiple points of stenosis, and the use of the bougie is found to be ineffectual. 3. Malignant disease of the rectum. Of the points which have to be now considered, the extent of the disease is the most important. A growth that is limited to the rectum, at whatever part it may be situated, and however high it may extend along the course of the bowel, may be removed by one of the methods about to be described. Extension beyond the rectum to surrounding parts, as shown by fixity of the growth to the sacrum on the one hand, or to the bladder, vagina, or uterus on the other, constitutes a contra-indication to any attempt at a radical operation as a rule; but

FIG. 307.



The sigmoidoscope. The obturator is not shown in the figure. The margin of the end of the tube is blunt, so that, once the instrument has been introduced well into the rectum, the obturator can be withdrawn and the tube advanced along the inflated rectum with the invaluable aid of sight, as advocated by Mr. Mummery.

the degree of adhesion may be most difficult to estimate, and in doubtful cases the patient may himself choose to undergo an operation which may perhaps be attended with unusual risk as long as there remains a fair prospect of obtaining relief of symptoms and prolongation of life, although the chances of a permanent cure may seem to be poor.

The sigmoidoscope is of decided value in enabling us to diagnose growths of the upper part of the rectum and of the lower part of the sigmoid colon at an earlier stage than hitherto. It also enables us to estimate the extent and mobility of growths which are too high for complete examination by means of the finger.

The administration of ether or A.C.E. may help here as well as in deciding the extent of the disease. The parts where it is most difficult and important to estimate the mobility are the neighbourhood of the prostate, urethra, and the neck of the uterus. Mr. Cripps thinks that though the bowel in contact with the prostate may be diseased, it is a long while before the prostate itself becomes infected. In women, on the contrary, when the disease is on the anterior part of the bowel, the vagina and uterus quickly become implicated. The recto-vaginal septum,

if involved in its lower part, may be cut away, but the patient will be liable to find fæces getting into the vagina, especially when the bowels are loose. The condition of the glands, sacral, iliac, and inguinal, will, of course, be examined, and the possibility of deposits in the liver remembered. Glandular infiltration is said by several to occur late in rectal carcinoma. This, at first sight a point which may favour operation, is counterbalanced by the well-known fact that rectal carcinoma is frequently insidious, and that thus, by the time it has pronounced its existence, it is already in an advanced stage. In doubtful cases an exploratory laparotomy is indicated, and is invaluable.

Finally, the age of the patient, this being not judged of by years alone, the condition of the kidneys and other viscera, whether the general condition and reparative powers are sufficiently good to meet the calls of what may be a very severe operation, must all be taken into careful consideration.

Much information bearing on the value of excision of the rectum will come out if we institute a **comparison between excision of the rectum and colotomy**. The chief points calling for attention are—(i.) The mortality of the operation. (ii.) The duration of life after it. (iii.) The amount of comfort given by it.

(i.) *The Mortality of the Operation*.—In making a comparison on this head between colotomy and excision of the rectum, one important point must always be remembered—i.e., that the latter operation is never performed under those unfavourable conditions of obstruction which, owing to the operation being often deferred till too late, render the mortality of colotomy such a high one. Turning to the mortality of excision by itself, without comparison with any other operation, we find that McCosh, in 1892 (*New York Med. Journ.*, Sept. 3), collected 439 cases, with 84 deaths, a mortality of 19·1 per cent. Later Kraske (*Ann. of Surg.*, vol. ii. 1897, p. 380) gives a mortality of 9·8 per cent., or 5 deaths in 51 cases operated upon during the years 1890—1897, and Paul (*Lancet*, vol. ii. 1897, p. 78) publishes a series of 28 cases, with 4 deaths, i.e., a mortality of 14·2 per cent. Tuttle found the mortality to be 20 per cent. in a collection of 1,578 resections, which were performed by various methods. Hartwell (*Ann. of Surg.*, 1905, vol. xlii., p. 399) analysed the results of 46 radical operations by 17 New York surgeons, and found the mortality to be 26 per cent.

In this, as in every other comparatively novel and important operation, a very large number of unsuccessful cases will remain unpublished, whilst nearly every successful case is reported at once. The real death-rate, therefore, when the facility with which shock, hæmorrhage, cellulitis, peritonitis, may occur in a part which cannot be kept absolutely aseptic, and in patients no longer young and the subjects of rectal cancer, is fairly estimated, lies probably between 15 and 20 per cent. Nor, when we consider how limited man's capacity for bearing grave operations remains, however much we have advanced in surgery, is it at all probable that the death-rate will fall much below 20 per cent., if all cases operated on are honestly reported. When we consider the mortality of inguinal colotomy for rectal cancer, excluding the cases where colotomy is performed under the most unfavourable circumstances of obstruction, in other words "the too late cases," the mortality will be distinctly less, varying from under 5 to under 10, accordingly as the

operation is performed by operators of especial experience or otherwise. Here, too, the value of statistics is greatly impaired by the tendency to publish only successes. But there can be no doubt whatever that colotomy in cases uncomplicated by obstruction is most distinctly a safer operation than excision of the rectum from the perinæum, and, *à fortiori*, than the severer methods.

(ii.) *Duration of Life*.—With regard to this point, I think a larger number of cases will show that if the surgeon decides to advise, and the patient is willing to run the risk of, the more serious operation, the prolongation of life will be greater here than after colotomy, if the cases are wisely selected. I think that the above is borne out by the results of the statistics which we have. It is rare for patients after colotomy for carcinoma to survive more than one year and a half. Making due allowance for the advanced date at which cases of rectal cancer too often come under treatment, for the fact that excision will usually be performed in selected cases, and that thus colotomy will be reserved for those less favourable, I think the published cases of excision show a greater prolongation of life.

Volkman (*Sammlung Klin. Vorträge*, May 13, 1878) claimed three complete cures and several cases of very late recurrence, viz., one after 6 years, one after 5, and one after 3. One case died of carcinoma of the liver 8 years after operation without local recurrence, and one case remained well 11 years after the removal of a large mass reaching high up; in this case recurrence occurred twice in the scar, and was removed. Czerny's experience is also very good. Two of his cases had survived the operation over 4 years, one 3 years and 4 months; three others were well after intervals of at least 2 years (Henck, *Arch. f. Klin. Chir.*, Bd. xxix. Hft. 3). Mr. Ball (*Diseases of the Rectum and Anus*, 2nd ed. p. 364) has had one patient alive and well 9 years and another 6 years after operation. Mr. Cripps (*loc. supra cit.*) has had one case free from recurrence 12 years, two 6 years, one 5 years, two 4 years, one 3 years, after operation. More recently Kraske (*loc. supra cit.*), in the series of 51 cases above referred to, states that 16 patients died from intercurrent disease, without signs of recurrence or metastasis, at times varying from 1½ to 5 years after the operation, and 15 patients were alive and free from recurrence three-quarters of a year to 8½ years after the operation. Keen (*Ther. Gaz.*, April, 1897) gives the results of 12 cases which survived the operation; 4 had passed the 4-year limit, and 2 others had nearly reached it, without recurrence. Hartwell (*loc. supra cit.*) states that 5 patients (11 per cent.) out of 44 were alive and free of recurrence over 3 years after the operation. Ten others were free of recurrence, but in only 2 of these had the operation been performed more than a year before the analysis was made.

(iii.) *Amount of Comfort Afforded*.—After this operation, as after excision of the larynx, a distinction must be drawn between mere survival and what deserves the name of recovery. The amount of comfort enjoyed by the patient will depend on—(1) the amount of contraction that takes place; (2) how far he has control over his motions. The patient should always be warned about these sequelæ. If he does not keep under observation, and contraction follows, I consider his case will compare most unfavourably with that after a

well-performed colotomy, and may even be as bad as that of a patient with advanced rectal cancer. (1) Where the whole circumference of the bowel has been removed, and a raw surface left, it is obvious that there must be a great risk of contraction in the scar tissue which replaces the mucous membrane. This contraction forms a most serious difficulty in the after-treatment, and is liable to lead to most unsatisfactory results. The more the connective tissue around the bowel is interfered with, the more profuse the suppuration, and the longer the healing, the more marked will the contraction be. Colotomy has been required for it, as occurred in a case under my care, where excision of the rectum had been performed elsewhere. The above risk may be obviated, no doubt, by drawing down the bowel and suturing it to the skin; but this step (p. 788) is not always feasible, especially in men, and if sutures are inserted they cut through quickly (*vide infra*). The severed end of the bowel is drawn considerably downwards during the process of healing. This renders it easier for the patients to pass a bougie from time to time, the need of which must be firmly impressed upon them. Another means of securing the patency of the bowel is by wearing a vulcanite tube, as recommended by Mr. Allingham. These are three or four inches long, with one end conical, and with the other ending in a broadish flange to prevent it slipping into the bowel, and also to enable it to be stitched to a bandage, which keeps it in place. Patients begin to wear it about a fortnight after the operation, and, save for taking it out when the bowels act, retain it constantly for some months, some having to wear it for the rest of their lives.

(2) As to the power of retaining fæces, incontinence is nearly always present at first, but control is usually regained after a time, save where the motions are loose. Mr. Cripps (*loc. supra cit.*) states that incontinence was present in only seven out of 36 cases which he collected. Torsion, after the advice of Gersuny (*vide infra*), as a preventive when the entire circumference of the bowel and the sphincters have been removed, has proved satisfactory in some cases (p. 800).

Operation.

The preliminary treatment is most important. The patient should be kept in bed for several days before the operation, and the strength and general condition improved as much as possible by the administration of plenty of light, easily digested, and nitrogenous food, which leaves but little residue. The rectum and large intestine should also be thoroughly emptied by means of mild purgatives and daily enemata. Although purgation is the only satisfactory way of bringing the colon and rectum into a state of comparative cleanliness, it must not be overdone, so as to weaken the patient; and no laxative should be given for at least twenty-four hours before the operation, but, on the contrary, peristalsis is to be inhibited by the administration of opium. The rectum and colon are thoroughly emptied by means of enemata the last of which is given about three hours before the time fixed for the operation. When the patient is under the anæsthetic, the bowel is washed out with an antiseptic solution. If the growth causes marked obstruction to the passage of fæces or to the efficient administration of enemata, lavage of the bowel, by means of a long rectal tube passed through the stricture, should be made use of. In order to promote rapid healing

and prevent suppuration as much as possible, every effort should be made to render the bowel as little septic as possible. To this end intestinal antiseptics, such as resorcin, salol, &c., may be administered by the mouth, and weak antiseptic solutions used for lavage and for the enemata. Commercial peroxide of hydrogen $\frac{1}{5}$, or perchloride of mercury $\frac{1}{5000}$ may be used. Where a rapid, soft growth, quickly ulcerating, has given rise to a foul discharge, Dr. E. H. Taylor (*Ann. of Surg.*, vol. i. 1897, p. 385) recommends curetting as a preliminary measure in order to bring about a sweeter condition of the growth and surrounding parts. He makes use of a flushing spoon for this purpose, and finds that the hæmorrhage is "trivial, and soon ceases." On the other hand, Kraske considers that this should be done only exceptionally, as it is not without danger. The perinæum and pubis are shaved and cleansed, and a suitable compress is applied on the evening before the operation.

Question of Colotomy before Excision of the Rectum.—Theoretically this preliminary step would seem very advisable, as diverting the fæces, and thus a source of decomposition, and as doing away with the need of the use of bougies to prevent contraction (Haslam, *St. Thomas's Hosp. Rep.*, vol., xviii. p. 151); but the opinions of authorities differ. Kraske only makes use of it when the growth is causing obstruction, and so prevents efficient emptying of the bowel before operation. He then makes the artificial anus in the transverse colon, as being less likely to interfere with the subsequent operation and more easy to close later. On the other hand, M. Quénu, quoted by Taylor (*loc. supra cit.*), always performs a preliminary inguinal colotomy, usually about twelve days before the main operation. Keen (*Journ. Amer. Med. Assoc.*, 1898) also is in favour of a colotomy, and, moreover, makes the artificial anus a permanent one by closing the upper end of the divided rectum after removal of the growth.

Hartwell (*loc. cit.*) also advocates a preliminary complete colotomy in all cases, maintaining that a controllable anus is a very rare thing after a satisfactory removal of the rectum for growth; in only two out of 46 cases was good function re-established. The risks of sepsis are lessened, and the probability of wide and complete removal of the growth is increased, when a permanent colotomy is adopted. He also believes that the combined mortalities of complete preliminary colotomy and resection would be lower than that of resection without preliminary artificial anus. The chief objections to a preliminary colotomy are that it causes loss of valuable time without a compensating advantage, since, with careful preliminary evacuation of the bowel, the operation and the after-course are quite satisfactory without it; that it saps the patient's strength and so diminishes his power of standing the more severe operation; and that, by fixing the bowel above, it may interfere with its mobility, thus preventing it from being efficiently pulled down at a second operation. Moreover, a third or even a fourth operation may be required to close the artificial anus after the new rectum has soundly healed. Finally, as remarked by Mr. Ball, the advantages of retaining a fæcal outlet in the perinæum are great, so long, of course, as this is not contracted.

It would seem, therefore, that the wisest course lies in reserving colotomy for (i.) those cases in which there is either declared or

threatened obstruction, preventing the proper evacuation of the bowel before the growth is excised; (ii.) cases in which it is fairly certain that it will never be possible to secure a controllable anus in the natural position. An inguinal artificial anus is preferable and more under the control of the patient than a sacral one, and it is far better than a long fibrous stricture, or the ulcerating track, devoid of any control, which so often follows an unsatisfactory perinæal excision. I have seen patients whose lives have been very miserable under these conditions, and who have been greatly relieved by a secondary colotomy.

CHOICE OF OPERATION.

The most suitable operation in a given case will vary according to the position and extent of the growth. For an early growth situated in the lowest two inches of the rectum the operation by a perinæal incision will usually suffice, and should be chosen on account of its low mortality. See table.

Tuttle collected 1,578 cases of extirpation of the rectum and sigmoid (pelvic colon):—

Method.	Number of Cases.	Deaths.	Mortality.
Sacral	913	211	23·1 per cent.
Perinæal	569	76	13·5 " "
Abdominal	49	18	36·7 " "
Combined	22	9	40·9 " "
Vaginal	23	3	14·3 " "
Anal	2	2	100 " "
Total	1,578	319	20·2 " "

In many cases, however, it is impossible to preserve functional sphincters by this operation, which is also accompanied by more hæmorrhage than either the sacral or the abdominal operation. When it is not possible to bring the bowel to the anus, and to re-establish control, it is probably better to perform either preliminary or secondary colotomy. In the female, especially when the growth is adherent to the vagina, the vaginal method may be chosen, and it has a low mortality.

When the growth does not extend higher than the middle of the sacrum, and does not involve the rectum as low as the sphincters, the sacral route is to be preferred. This is especially true if there is any adhesion to the sacrum or coccyx. Bone flap operations have recently come into greater favour again, and the risk of necrosis is not considerable if the bones are not wired together, and only the soft parts are sutured, when good union generally follows with firm re-establishment of the pelvic floor and attachments of the pelvic diaphragm. In some

cases, when the bowel above the growth cannot be liberated sufficiently, the abdomen may be opened for this purpose, through the lower part of the left rectus muscle. In one case I avoided this necessity by seeking and drawing down a mobile sigmoid loop from the sacral wound. The middle of the loop was easily brought to the anus without any tension. When this fact was recognised, there was no need to preserve the blood supply of the upper part of the rectum, which, together with the lower part of sigmoid, was easily removed through the sacral wound.

The hæmorrhage, which used to be the terror of this operation, is largely avoided by securing the vessels at the upper end of the incision and then dissecting the bowel from its anterior connections from above downwards, instead of in the reverse direction. The dangers of infection of the peritonæum are minimised by taking care not to open the bowel before it is withdrawn from the wound. Every effort should be made to bring healthy and vascular intestine down to the lower segment, or, if possible, to the anus, without tension. Failing this, a sacral anus may be made, the bowel being drawn out through the pyiformis and gluteus maximus as well as twisted after Gersuny's method.

When the growth is entirely above the peritonæal reflection, and the finger cannot reach beyond the growth, an abdominal exploration should be recommended. This enables the surgeon to examine for secondary growth and enlarged glands, and to determine the extent and mobility of the tumour. He can then choose his subsequent procedures. When secondary growths exist it may be wise to close the abdomen without even performing colotomy. When the growth is irremovable a permanent artificial anus can be at once performed. In other cases with accumulation of fæces, especially of scybala, a temporary artificial anus may be made, to be followed later by resection by the sacral, abdominal, or one of the combined methods.

When the growth occupies the upper part of the rectum or the pelvic colon one of the abdominal or combined methods should be selected, and it is to be hoped that recent improvements in technique may reduce the high mortality which has attended these operations, until quite recently. The methods described by Sir Charles Ball and Miss Aldrich Blake have much to recommend them, but they are not capable always of application. Under these circumstances the surgeon must make an artificial anus, so that he may not be tempted to remove too little of the rectum on the one hand, or to join parts which are ill-nourished or under too great tension on the other. Whenever possible it is wise to bring the upper segment to the anal margin, or at least below the pelvic diaphragm. Sepsis, which is the chief cause of failure here, is thus prevented to a great extent. With the same object always in view, the surgeon should refrain from dividing the intestine until the peritonæum has been closed by suture or packing, and until the bowel has been drawn out of the wound if possible. Failing this, the division must be made between clamps or ligatures, and the ends sterilised and covered.

I. Perinæal Excision.—When the disease involves the anal canal or the very lower part of the rectum Allingham's method may still be used (Figs. 308, 309), but when the growth is a little higher and the

external sphincter can be saved it is better to adopt the following adaptation of Quénu's* method:—

The patient is anæsthetised and placed in the lithotomy position with the pelvis slightly raised. The rectum is cleansed, dried, and

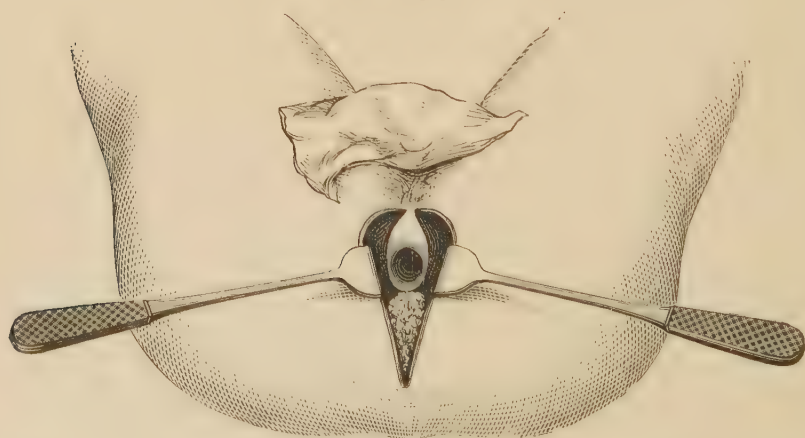
FIG. 308.



Perinæal excision of rectum. The patient is placed in lithotomy position, and the surgeon makes an oval incision into both ischio-rectal fossæ around the bowel, then prolongs this oval incision backwards so as to reach the coccyx. (Allingham.)

loosely packed with gauze so that its wall may be easily recognised and avoided during the later stages of the operation. The vagina is also washed out and the bladder emptied. An incision is made close to

FIG. 309.



(Allingham.)

and around the anus, and the mucous membrane of the anal canal is dissected up for about half an inch, where it is firmly tied by means of a strong silk ligature, and the end of the stump is sterilised with

* Quénu, *Rev. de Gynéc.*, September, 1898; Tuttle, *Diseases of the Rectum and Colon*, 1903.

the cauter. The ends of the elliptical incision are then continued backwards as far as the tip of the coccyx and forwards into the perinæum nearly as far as the scrotum. The fibres of the external sphincter are separated and divided exactly in the middle line anteriorly and posteriorly, and drawn aside with the skin (Fig. 310).

The posterior wound is deepened and the rectum is freed upon its posterior and lateral aspects, the levator ani being divided close to the rectum (Fig. 311). The anterior fibres are divided last after being isolated by passing the finger forwards and upwards close to rectum (Fig. 311). By blunt dissection the rectum is then freed from the sacrum, and from the loose pelvic cellular tissues upon its lateral aspect.

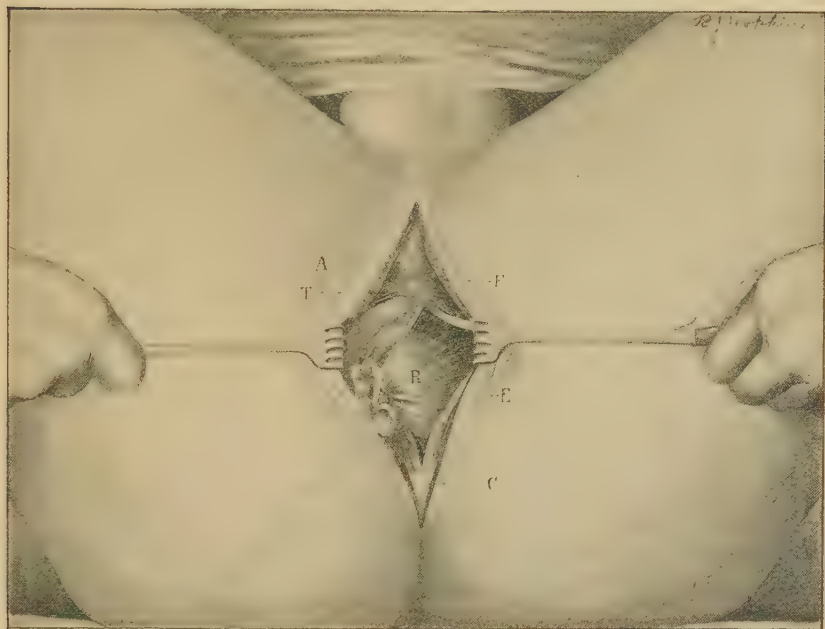


FIG. 310.—PERINÆAL EXTIRPATION OF THE RECTUM (Quénu's method
R, rectum; *E*, external sphincter; *C*, coccyx; *T*, transversus perinæi muscles; *A*, bulbous urethra. (Tuttle.)

The separation of the bowel in front varies with the sex of the patient. In a male, a full-sized metal sound having been passed into the bladder and kept well hooked up under the pubes, the surgeon carefully dissects, partly with his finger and partly with scissors, between the bowel and urethra and prostate. These parts are naturally adherent, and this dissection must be carefully conducted, as any opening into the bladder or urethra or injury of the ureters is a serious matter. As it is freed the bowel is drawn backwards and downwards so as to afford a good view of the depth of the wound (Fig. 312); disarticulation of the coccyx, which is then folded backwards, facilitates this procedure.

In the case of a woman the surgeon's left index, or the finger of an assistant in the vagina, will give the best warning of his knife or

scissors (the latter, long and blunt-pointed, are preferable) getting too near the vaginal mucous membrane. If this be encroached upon, it must be removed without hesitation, and the opening thus made closed towards the end of the operation (p. 802).

On continuing the dissection upwards the peritonæal pouch in front of the rectum is displayed. In some cases, when the growth does not extend beyond this pouch, it is possible to avoid opening the peritonæum by displacing the peritonæum upwards by blunt dissection. In the majority of cases, however, it is best to open the peritonæum at its lowest point (Fig. 313), and then to continue the incision to either side close to the rectum until the meso-rectum is reached. This is

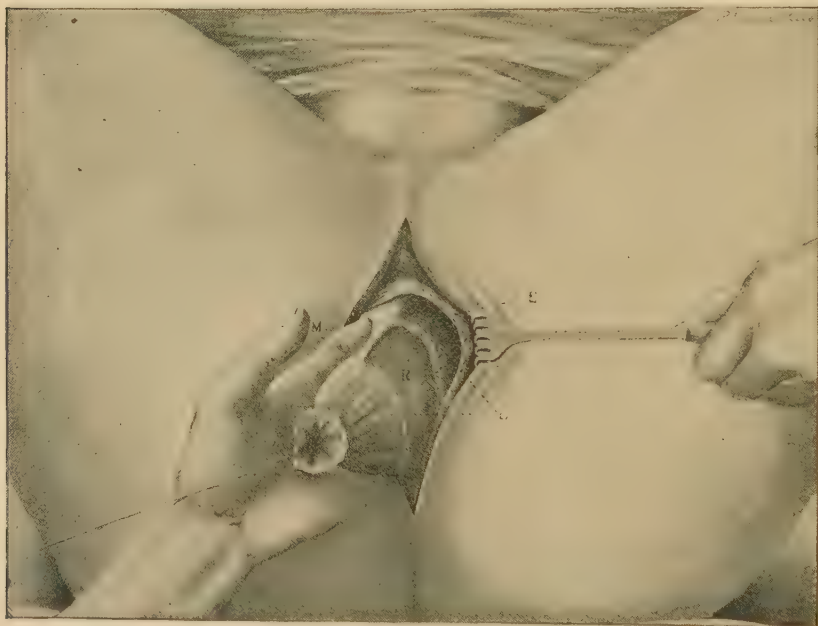


FIG. 311.—PERINEAL EXTIRPATION—LOOSENING RECTUM FROM ANTERIOR PERINEAL RHAPHE.

L, levator ani; *R*, rectum; *M*, rhapshe. (Tuttle.)

divided close to the sacrum so that it can be drawn downwards with the bowel. This avoids the risk of dividing the superior hæmorrhoidal artery at this stage in the depth of the wound, and also enables the surgeon to remove the glands within the meso-rectum.

The small intestines are packed away with gauze, which also serves to collect any blood which tends to gravitate towards the abdomen when the pelvis is elevated. The rectum is separated freely enough to allow the growth to be drawn well out of the wound, and the bowel at least an inch above the disease to be brought down and sutured without tension to the anal skin. The superior hæmorrhoidal artery is tied and divided. The parietal peritonæum is then sutured to the serous covering of the rectum, with the double object of closing the peritonæal cavity as far as possible and lessening the tendency to retraction.

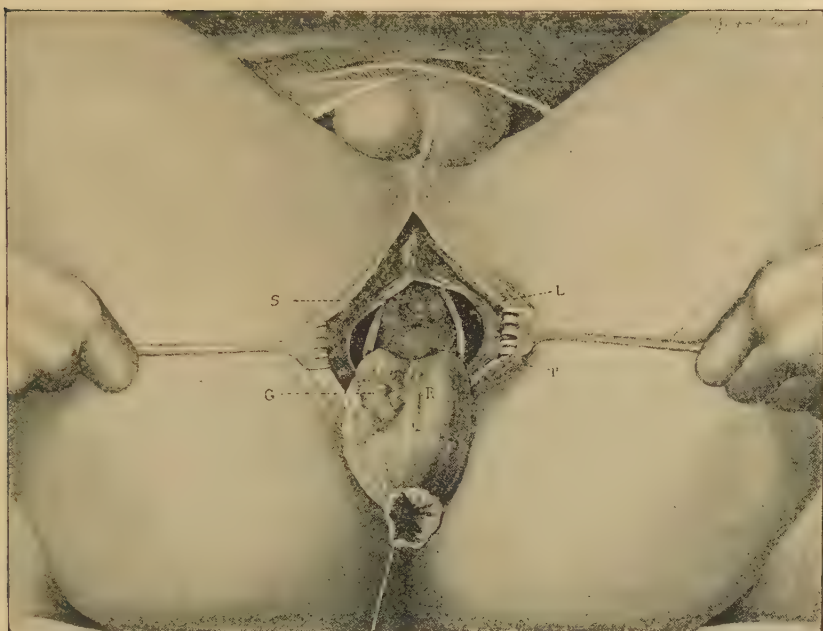


FIG. 312.—PERINÆAL EXTIRPATION.

R, rectum ; *L*, levator ani ; *G*, neoplasm ; *P*, peritonæal pouch ; *S*, seminal vesicles and prostate. (Tuttle.)

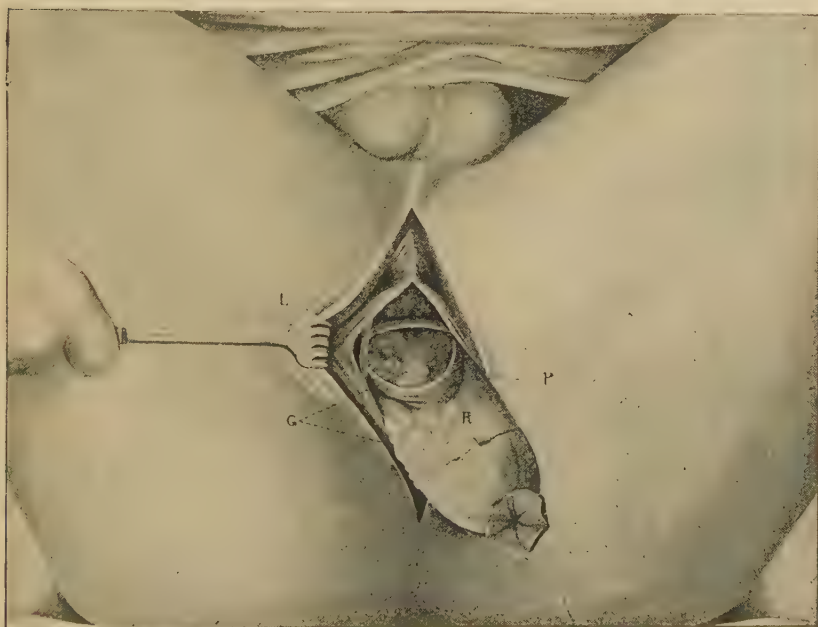


FIG. 313.—PERINÆAL EXTIRPATION—THE PERITONÆAL POUCH LAID OPEN.
(Tuttle.)

Next the edges of the levator ani are sewn together and to the side of the rectum; this serves to reconstitute the pelvic floor, to limit retraction and do away with the dead space, which otherwise tends to fill with blood or serum and to get infected.

The bowel is drawn down and clamped well above the growth with long curved intestinal forceps, the handles of which are below or behind. These prevent any leakage, retraction, or hæmorrhage during the next stage. The rectum is cut across one-third of an inch below the forceps and at least one inch above the disease. The margin is then accurately joined to the anal skin, with numerous interrupted silk sutures, which pierce all the coats of the rectum and secure a good hold.

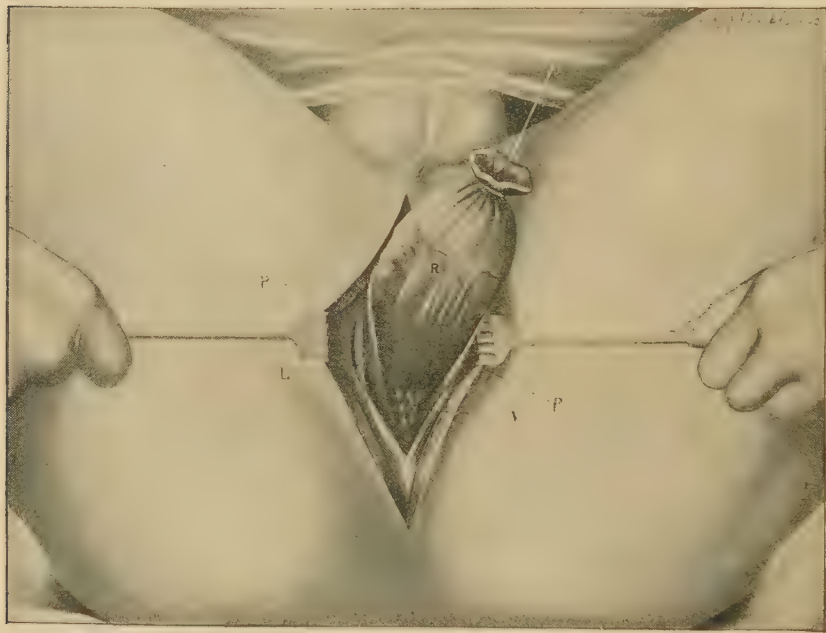


FIG. 314.—PERINEAL EXTIRPATION.

P, lateral peritoneal folds; *V*, glandular enlargement between folds of meso-rectum.
(Tuttle.)

The anterior and posterior wounds are closed near the rectum by sutures which pass deeply and bring the divided ends of the external sphincter together. The wound is drained, and a tube is passed into the rectum (Fig. 315).

Mr. Cripps considers that any attempt to bring down the cut edges of the rectum, and to stitch them *in situ* around the anus, is perfectly useless, as the sutures are certain to cut their way out, and harmful, as likely to prevent the escape of discharges. As this entails the very serious risk of septicæmia, the advantage which suturing the bowel would give, if it were safe, of preventing subsequent contraction (p. 779) has been put aside.

On the other hand, Volkmann, Czerny (*loc. supra cit.*) and others have recommended the use of sutures so as to hasten healing and

obviate the tendency to stricture. If they are employed, they must be passed as advised by Ball, not only through skin and bowel, but also deeply through the surrounding pelvic structures as well; drainage-tubes should also be inserted here and there between the sutures. Superficial sutures are then put in as well, so as to further diminish the strain. If these precautions are taken, if no faecal contamination of the wound has occurred, if antiseptic precautions have been taken throughout, and if the wound has been rendered thoroughly dry and bloodless, the employment of sutures is recommended in appropriate cases.

Mr. Bidwell (*Brit. Med. Journ.*, Oct. 21, 1899) recommends the following plan to enable the edges of the wound to be brought together.

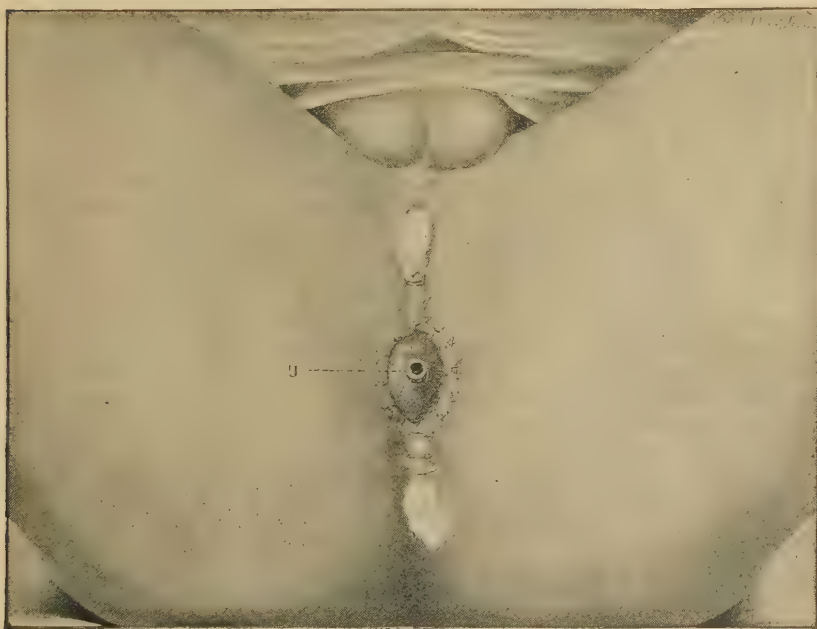


FIG. 315.—PERINEAL EXTIRPATION COMPLETED.

U, tampon and drainage-tube in anus. (Tuttle.)

Two transverse incisions about two inches long are made on each side of the perineal incision. The flaps of skin so formed are then dissected up and attached to the cut edge of the rectum by means of silkworm gut sutures. As a rule, this can be carried out without undue tension, but should there be any, a longitudinal incision in the posterior surface of the rectum will enable the union to be effected.

If the growth reaches the skin of the anus the inguinal lymphatic glands must be carefully examined, and, if found enlarged, they must be removed either at once or at a second operation. If the bowel cannot be sutured in the position of the anus, Taylor (*loc. supra cit.*) recommends that "it be drawn backwards in the middle line between the levatores ani and a subcoccygeal anus formed. The wound in front is then closed by deep sutures. As Mr. Ball points out, they

have the great advantage of not leaving recesses about the rectum in which serum might collect and decompose. These deep sutures should, of course, include the levatores ani; our object being to reconstruct a sphincteric apparatus."

Question of partial removal.—If any of the mucous membrane, even a mere strip, can be *safely* left, the amount of subsequent contraction will be less; but here, as in all other operations for malignant disease, every consideration must give way to the chief object, that of extirpating the growth.

Partial operations should be reserved only for cases where the disease is very localised in amount, and admits of extirpation, together with a very wide margin of bowel. Where the disease implicates one-half of the bowel, even if apparently not disseminated in the mucous membrane, the whole circumference should be removed. Mr. Allingham thus condemns partial operations: "The partial removal of the circumference of the bowel is, in my opinion, most unsatisfactory. In all the cases in which I have removed only part of the wall there has been either a return of the disease in the rectum, or in the glands in the groin, or in some internal organ, mostly the liver."

If the surgeon decide on a partial operation, he must be prepared for some increased difficulty, owing to the diminished room for working, and meeting the hæmorrhage. Perhaps only one semilunar incision around the anus will be required.

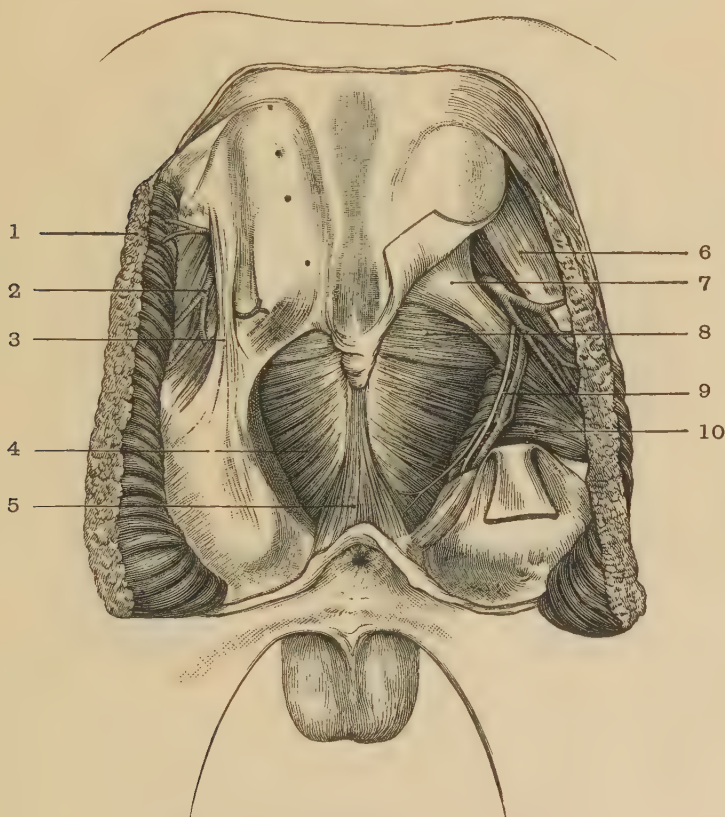
In rare cases a growth which forms the presenting part of an intussusception, or a growth limited to one aspect of the rectum, may be capable of withdrawal through the dilated anus. In such cases, which are early ones with unusual mobility and freedom from invasion of neighbouring tissues, the intussuscepted mass can be safely resected, and the remaining healthy ends joined together after Maunsell's method (*vide* p. 364), but the lymphatic glands cannot be removed.

(ii.) **Kraske's Operation and its Modifications** (Fig. 319).—Kraske, of Freiburg (*Arch. f. Klin. Chir.*, Bd. xxxiii. S. 563), introduced this route as best adapted for those cases which, in Volkmann's words, are situated too high for the perineal route and are too low and too fixed to admit of removal by abdominal section. It will be understood by all that this is an operation of great severity, and only justifiable when, as compared with colotomy, the risks on the one hand, and the advantage on the other, of attempting a radical cure, and, at all events, affording a greater prolongation of life (p. 778), have been fairly put before the patient or the friends. Again, it is only a surgeon who has had large operating experience who should undertake, and only patients who have sufficient reparative power who should be submitted to, any of these operations of excision of the rectum, more particularly to this and the ones that follow. For at least four days before the operation the patient should be prepared by aperients and enemata and a wisely restricted fluid diet.* The parts having been previously shaved and cleansed, the latter process is repeated when the patient is passing under the anæsthetic, and the bowel cleansed as high up as possible

* Dr. C. B. Kelsey (*New York Med. Journ.*, vol. ii. 1895, p. 457) advises that a dose of morphine and bismuth should be given on the evening before, and repeated a few hours before the operation. The paper is an excellent one, full of practical hints from which I have borrowed largely.

by irrigation with lot. hydr. perch. (1 in 5000), and with swabs of iodoform gauze on long forceps. A tampon of iodoform gauze may be left in the rectum for localising purposes, but too large a mass obscures palpation of the diseased part from the incision. Every care must be taken not to open the bowel during its liberation. The patient

FIG. 316.



From a dissection made by Mr. E. H. Taylor.

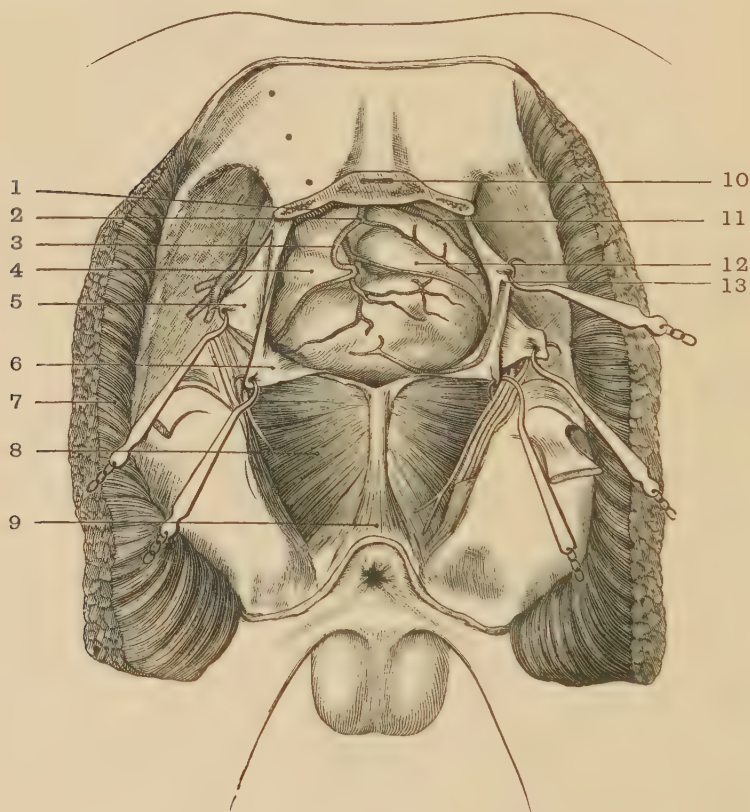
The black dots over the sacrum indicate the levels of the first, second, third, and fourth posterior sacral foramina.

- | | |
|----------------------------------|---|
| 1. Gluteus maximus muscle. | 6. Piriformis muscle. |
| 2. Sciatic artery. | 7. Lesser sacro-sciatic ligament. |
| 3. Great sacro-sciatic ligament. | 8. Coccygeus muscle. |
| 4. Levator ani. | 9. Internal pudic artery and pudic nerve. |
| 5. Sphincter ani externus. | 10. Obturator internus muscle. |

may be on his right side as recommended by Kraske, or on his face, or, again, in the lithotomy position, according to the convenience of the operator. If the thighs are kept well flexed, and a sand pillow is placed under the lumbar spine, it will be found that the lithotomy position is very suitable, the intestines in this position falling away from the recto-vesical pouch, the separation of the peritonæum

being thus facilitated, and moreover, the light coming from above, the deep wound will be well illuminated, and the whole of its extent well under the eye of the operator. Whatever be the position, the pelvis should be elevated, so as to diminish hæmorrhage. An incision is then

FIG. 317.



From a dissection made by Mr. E. H. Taylor.

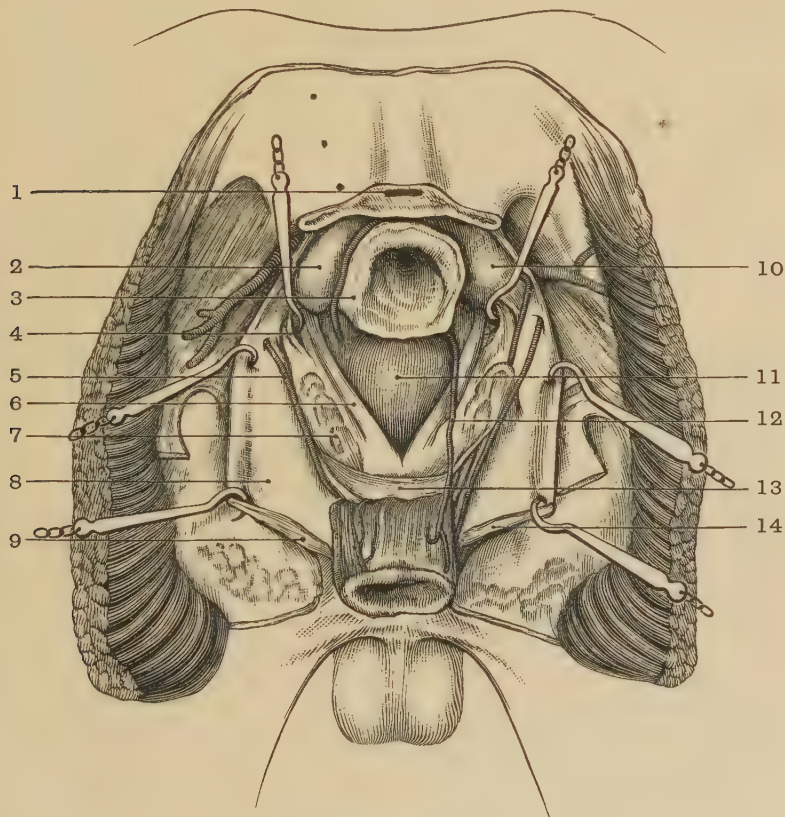
The black dots over the sacrum indicate the levels of the first, second, and third posterior sacral foramina.

- | | |
|---|---------------------------------|
| 1. Lateral sacral artery. | 7. Gluteus maximus muscle. |
| 2. Middle sacral artery. | 8. Levator ani. |
| 3. Superior hæmorrhoidal artery (left main division). | 9. Sphincter ani externus. |
| 4. The pelvic peritonæum. | 10. Sacral canal. |
| 5. Lesser sacro-sciatic ligament. | 11. Lateral sacral artery. |
| 6. Pelvic fascia. | 12. Rectum. |
| | 13. Middle hæmorrhoidal artery. |

made in the middle line from the posterior edge of the anus to the centre of the sacrum, the knife being carried down to the bone at once. A flap on the left side is then turned outwards, including a part of the gluteus maximus, and exposing the side of the sacrum and the sacro-sciatic ligaments. These last must be divided and detached from both

sides of the coccyx and the left side of the sacrum, together with the coccygeus, part of the left pyriformis and, if the anal region is to be removed, the sphincter and levator ani. With a periosteal elevator

FIG. 318.



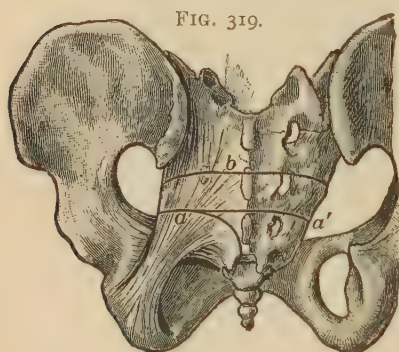
From a dissection made by Mr. E. H. Taylor.

The black dots over the sacrum indicate the levels of the first, second, and third posterior sacral foramina.

- | | |
|--|--|
| 1. The sacral canal. | 9. Cut surface of the ano-coccygeal raphé. |
| 2. The pelvic peritonæum. | 10. The pelvic peritonæum. |
| 3. The rectum. | 11. The bladder. |
| 4. The ureter. | 12. Superior hæmorrhoidal artery (right division). |
| 5. Middle hæmorrhoidal artery. | 13. Pelvic fascia (recto-vesical layer). |
| 6. Vas deferens. | 14. Cut surface of the ano-coccygeal raphé. |
| 7. Seminal vesicle. | |
| 8. Pelvic fascia, clothing the upper surface of the levator ani. | |

passed under the sacrum the soft parts are now detached from the hollow of this bone, including the sacra media vessels and a venous plexus, thus avoiding troublesome bleeding. The surgeon must now decide how much bone requires removal. Reference to the lines of bone-section indicated in Fig. 319 will show the extent to which bone

is removed in Kraske's original operation, and in some of the chief modifications of this. No hard-and-fast lines can, however, be laid down, since the amount of room required, and therefore the amount of bone which must be removed, must depend entirely upon the extent of the growth and the size of the outlet of the pelvis. Kraske (*loc. supra cit.* p. 499) does not now recommend removal of any bone beyond the coccyx except when this is necessary in order to get sufficient room. Senn (*Philad. Med. Journ.*, Sept. 30, 1899) has come to the conclusion that resection of the sacrum is not only needless, but absolutely harmful, and maintains that removal of the coccyx only will *always* be sufficient. The coccyx should therefore be removed in the first instance; if then the amount of space obtained is found to be insufficient, resection of the sacrum must be resorted to. Taylor (*loc. supra cit.*) advocates temporary sacral resection, as first practised by Heinecke, and later by Rehn and Rydygier, chiefly on the ground that this prevents the loss of posterior support of the levatores ani



a. The incision, through the sacrum, of Kraske's (p. 792). a, a'. That of Bardenheuer, who takes away the whole lower part of the bone as far as the third sacral foramina. b. Incision of v. Volkmann and Rose which passes through the bone at a higher level still. (Esmarch and Kowalzig.)

which results from permanent resection. The chief objections to this plan are, that it does not give so much room, that the bone-flaps are liable to necrosis,* and that the formation of a sacral anus is not possible. In suitable cases, however, such as the successful one which Taylor describes, the method has much to recommend it, but, as a general rule, it will be found that sacral resection as carried out by Kraske will be as efficient as the more complicated methods, and, moreover, is more rapid in performance and more suitable for the formation of a sacral anus should this be necessary. The soft parts being vigorously retracted the surgeon cuts through the left side of the sacrum along a curved line (Fig.

319) commencing on the left edge, at the level of the third posterior sacral foramen, and running inwards and downwards through the fourth foramen to the left corner of the sacrum. By cutting along this line the anterior division of the third sacral nerve will not be divided nor the sacral canal opened. The bleeding up to this time, which is largely venous, is best met by firm sponge or finger pressure; much time will be lost in attempting to seize the bleeding points in the usual way. As soon as the bone is out, the vessels may be closed by forcipressure or, where needful, by under-running. The hæmorrhage comes chiefly from the lateral and middle sacral, the hæmorrhoidal arteries, the bone itself, and a venous plexus on both aspects of the sacrum. The pelvis is, in this way, freely

* If the bones are not wired, but apposition obtained by means of catgut sutures in the soft parts, necrosis does not occur. Tuttle (*loc. cit.*) has not noticed any want of union or necrosis in any of his 20 cases (*vide* Figs. 320 to 325).

opened, and from six to eight inches of the bowel may be removed. The tissues, down to and including the levatores ani, are now divided along the median raphé behind, and the separation of bowel commenced. If the growth does not reach to within an inch of the external sphincter, this, together with the anus, is left intact; if, on the other hand, there is any suspicion that the external sphincter and anal region may be involved by the growth, these must be removed. Unless matted by extension of the disease, the bowel will readily be shelled out of its bed, posteriorly and laterally. In Dr. Kelsey's words (*loc. supra cit.*), "the finger cannot be passed completely under and around the gut on account of its size at this point, nor can it be drawn

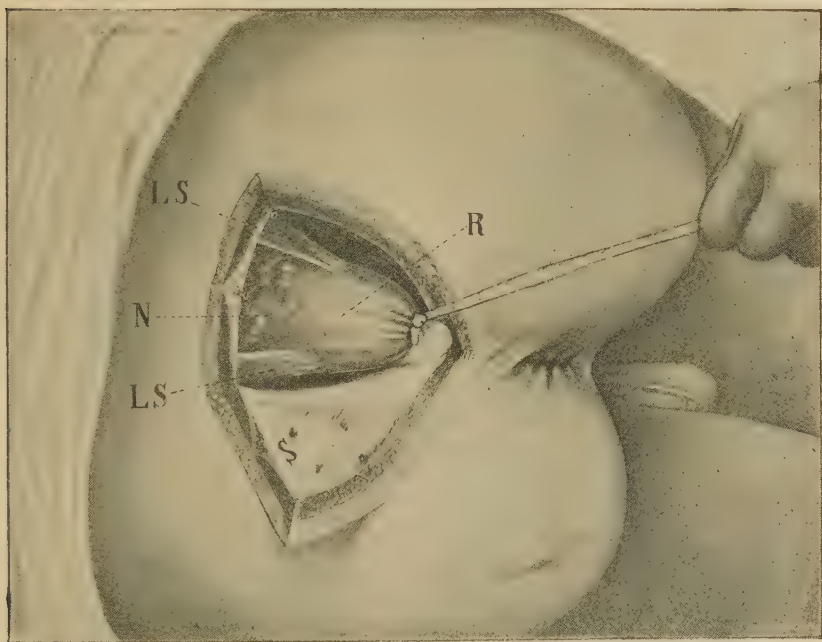


FIG. 320.—SECOND STEP IN BONE-FLAP OPERATION.

R, rectum; *N*, neoplasm; *LS*, lateral rectal ligaments; *S*, sacrum. (Tuttle.)

down at all on account of the firm attachments of the peritonæum and the meso-rectum. Any forcible attempt to drag it down at this stage is attended by great risk of rupture and consequent soiling of the wound, and all that should be attempted is gentle isolation on each side by separating it from its loose attachments with the finger, and discovering by touch the extent of the disease to be removed, which can generally be easily done by palpating the tube as it lies in the wound." On continuing the blunt dissection at the upper end of the wound the peritonæal reflection will be reached on the anterior wall; if this is found to lie well above the upper extremity of the growth it may be possible to separate it upwards with the finger to the desired extent, and thus avoid opening the peritonæal sac altogether. Should it be found, however, that the growth extends above the level of the

peritonæal reflection, it will not be possible to separate the peritonæum, and the fold should then be opened freely at once. This step is necessary in the large majority of cases, and it is better to take it early in the operation, for once the peritonæal attachments are divided, it is far easier to bring the rectum down, and also to avoid injuring the ureters. The serous membrane is incised close to the rectum on the front and sides of the latter, but higher up and further back the mesorectum is severed close to the sacrum, so that the hæmorrhoidal artery may be avoided and the lymphatic glands removed with the growth. The rectum and the presacral cellular tissues are carefully separated from the concavity of the sacrum to the desired extent, gentle traction being

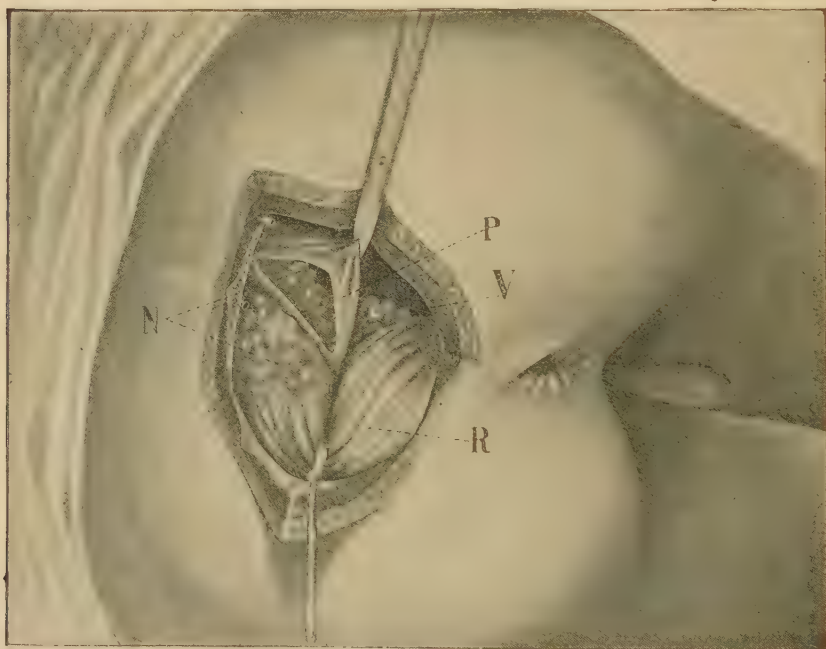


FIG. 321.—THIRD STEP IN BONE-FLAP OPERATION.

P, opening in the peritonæum ; *V*, seminal vesicle and bladder ; *N*, neoplasm ; *R*, rectum. (Tuttle.)

made on the bowel while this is being done. When the bowel at least an inch above the growth can be brought down to the healthy segment an inch below the disease, or better still to the anal margin, the peritonæal cavity is cleansed and closed with sutures, some of which are passed through the serous covering of the rectum well above the disease. A gauze pack may be used instead of sutures, which are difficult to insert, and packing is just as safe. After this important step has been taken the bowel about an inch and a half above the growth is divided between two clamps, and the ends sterilised with pure carbolic acid. The superior hæmorrhoidal artery is tied. The growth and the lower portion of the rectum are then drawn downwards and separated by blunt dissection from the bladder and prostate or from the vagina. This dissection is far simpler and safer when conducted from above

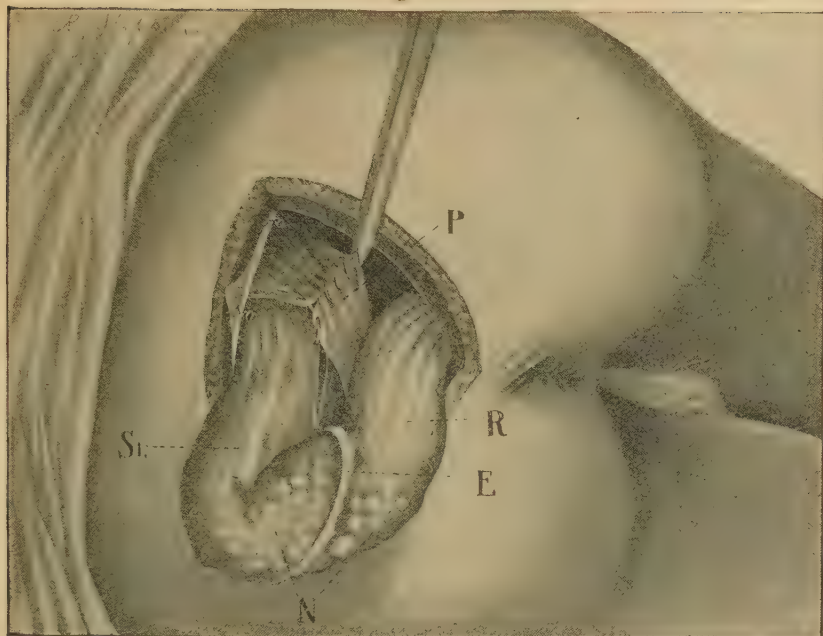


FIG. 322.—FOURTH STEP IN BONE-FLAP OPERATION.

R, rectum ; *Si*, sigmoid ; *E*, site of recto-vesical *cul-de-sac* ; *P*, peritonæal cavity closed. (Tuttle.)

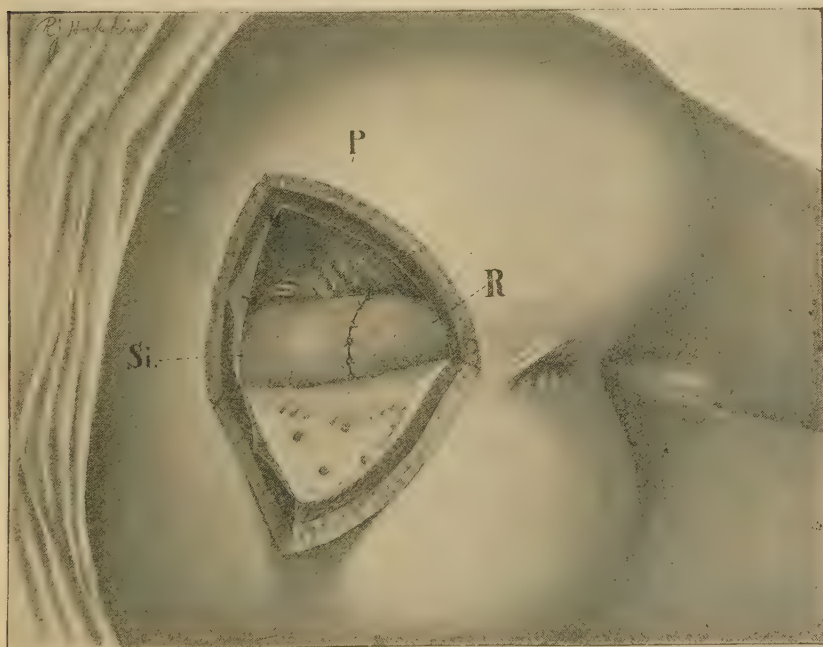


FIG. 323.—FIFTH STEP IN BONE-FLAP OPERATION.

The growth has been resected, and the ends of the intestine have been sutured together. (Tuttle.)

downwards instead of in the reverse direction; moreover, it is accompanied with much less hæmorrhage (Tuttle). A sound in the urethra and bladder in the male, and an assistant's finger in the vagina in the female act as useful guides in difficult cases. When the separation has been carried well below the growth, the bowel is clamped, and divided an inch below the disease. As soon as the growth is removed the upper stump must be wrapped up in a piece of iodoform gauze while the wound is attended to. All bleeding must be arrested, vessels ligatured, and the wound wiped over with pledgets of gauze wrung out of hot perchloride or formalin lotion (1 in 2000).

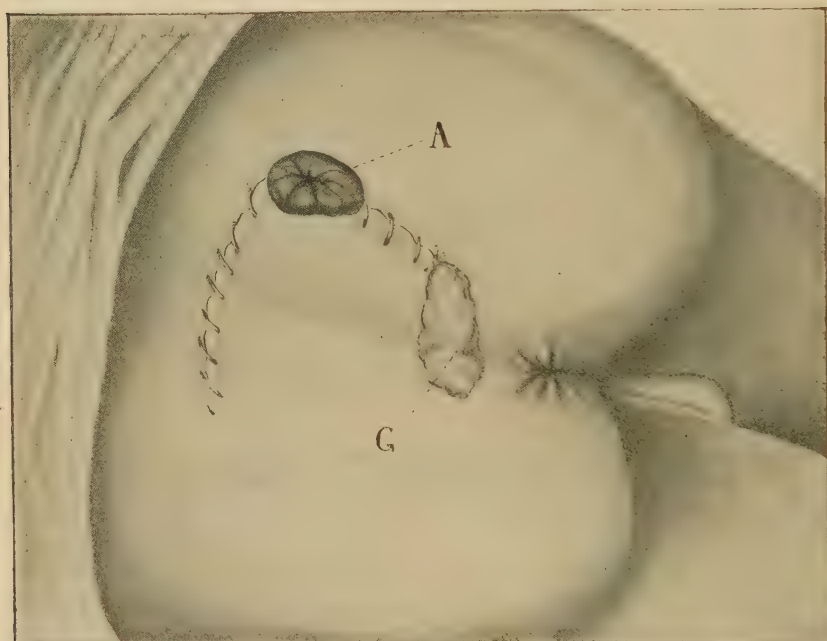


FIG. 324.—SACRAL ANUS.

Made in bone-flap operation when it was impossible to establish aperture in normal position. (Tuttle.)

Treatment of the Ends of the Bowel.—The methods advocated by different surgeons as regards this most important step vary very considerably, and at the present time it cannot be said that the question is by any means settled. Kraske (*loc. cit.*, p. 778) after having abandoned it for some time, on account of repeated failures, has finally returned to his original plan of immediate direct suture, finding that complete or almost complete union can be obtained if the bowels are kept constipated for eight to ten days after the operation. The anterior and lateral portions are united by two tiers of sutures, one passing through the whole thickness of the bowel, and the other through mucous membrane only. The posterior part is closed by inverting sutures not involving the mucous surface. Where the growth does not reach very low down this method may be carried out, but if the external sphincter has to be sacrificed, a sacral anus may be

formed by fixing the upper divided end of the bowel to the posterior angle of the wound as recommended by Hochenegg (*Brit. Med. Journ.*, vol. i. 1900, p. 1031). When end to end union is attempted it is well to pass a few sutures through the meso-rectum and the skin in the neighbourhood of the coccyx to lessen the tendency of the bowel to retract. Paul, who gives a series of twenty-eight cases with four deaths (*Lancet*, vol. ii. 1897, p. 78), has abandoned approximation of the divided ends if more than three inches of the rectum have been removed, and uses one of his tubes (Fig. 54) in the following manner, as described in a former paper. The rectum is first thoroughly freed by opening the peritonæal sac, and dividing as much of the meso-rectum as is necessary.

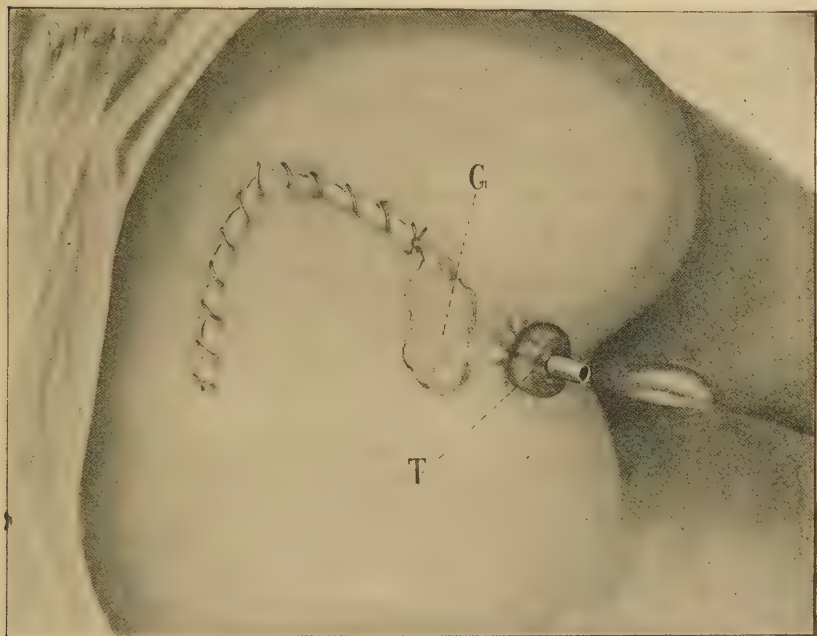


FIG. 325.—FINAL STEP IN BONE-FLAP OPERATION.

G, gauze draining retro-rectal space ; T, tampon and drainage-tube in anus. (Tuttle.)

“When plenty of the bowel has been drawn down, the rent in the peritonæum may be loosely closed with a few fine sutures, and a large glass intestinal drainage tube, plugged with wool, is inserted into the bowel and ligatured above the growths. If the intestine is loaded with fæces the tube had better be introduced below the stricture and forced up,* to the detriment of the specimen, as it is very difficult to avoid some escape of fæces when this powerful bowel is opened under high pressure. The tube having been fastened in, the diseased part is cut off and the stump sutured to the top corner of the wound ; the higher the better,

* This would appear to me to run some risk of carrying up cancer cells on the upper edge of the glass tube, and perhaps infecting the cut edge of the bowel above, when the gut is severed very shortly after.

as less gut needs to be drawn and the orifice is in a more favourable position for the truss* (*Brit. Med. Journ.*, 1895, vol. i. p. 520).” This method of inserting a tube has the advantages of being simple and rapidly used; it also prevents contamination of the wound with fæces, and further, any large vessels in the intestinal wall are closed with a single ligature. The tube becomes loose about the fourth day. The disadvantage of the tube is that its presence prevents the surgeon from fashioning a smaller artificial anus. But this is a minor point. However well the anus may look at the time, artificial support is almost certain to be required later on, when part of the sacrum and coccyx has been removed. Hence, to prevent prolapsus, and to aid in giving a patient control, such a truss-pad as that of Mr. Paul’s will be found a real boon (*vide* Fig. 326).

Gersuny (*Centr. f. Chir.*, 1893, No. 6) advocates treating the upper end of the rectum, if long enough, by torsion, and then fixation of the twisted gut to the skin by suture. The end is grasped by catch-forceps and twisted around its own long axis until considerable resistance is

experienced on attempting to introduce the finger into the bowel. He has treated two cases in this way successfully. Mr. Ball (*loc. supra cit.*) has also used it in one case, and recommends it. Dr. Gerster, of New York, has published two cases in which he adopted this plan successfully, and thinks that the method deserves preference and extensive trial (*Med. Record*, Feb. 10, 1894; *Ann. of Surg.*, Oct. 1895, p. 499).

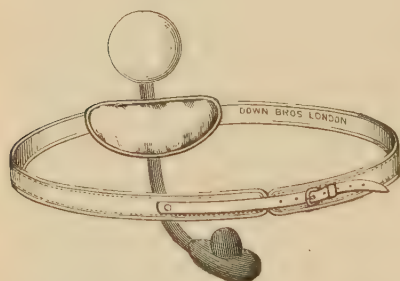
Witzel† reports (*Centr. f. Chir.*, 1894, No. 40) six successful cases in which the end of the rectum

was treated as follows. A short incision having been made a little above the free margin of the gluteus maximus, this muscle is perforated with a blunt instrument, and the rectal stump drawn through, the edges of the gut being united to those of the skin.

Murphy’s button has also been used to unite the ends of the bowel, a successful case being described by Taylor (*loc. supra cit.*) in which “the button was removed on the tenth day by gentle traction through the anus and the bowels were made to act. Some fæces, however, came by the wound.” The fistula rapidly contracted and was completely closed about six weeks after the operation.

Taylor also describes a successful case treated by the method of Moulonguet of Amiens. “He removes the mucous membrane of the lower segment down to the anus, taking good care not to injure the external sphincter. When the cancer has been excised he draws down

FIG. 326.



Paul's truss for use after excision of the rectum.

* *I.e.*, the rectal pad carried by the truss will be more out of the way, especially when the patient is sitting down. Mr. Paul's truss is figured in the above-mentioned paper.

† Willems and Rydygier had recommended a similar step before, from experiments on the dead body (*Centr. f. Chir.*, 1893, No. 19; 1894, No. 45).

the upper end and sutures it to the sphincteric orifice. Moulounguet remarks that with this method there is less chance of abscess and fistula, since the intestine opens on to the exterior." This method is to be strongly recommended, for the chances of infection of the deeper parts of the wound and dangerous cellulitis are greatly diminished by it.

Keen (*Journ. Amer. Med. Assoc.*, 1898) is in favour of total closure of the lower end and establishing a permanent abdominal anus. He performs a preliminary inguinal colotomy, and about a fortnight later removes the rectum by Kraske's method. The lower end of the bowel is, however, closed entirely by means of sutures. The advantages claimed are that neither fæces nor mucus escape into the wound, so that primary union may be obtained; that, since there is no escape of fæces or mucus after recovery, the patient need not wear a napkin; and, thirdly, that prolapse is avoided.

The question of the treatment of the end of the rectum having been decided, the gut placed in the position which it is to occupy, and a source of contamination thus removed, the wound must be attended to. If a bone flap has been used it must be replaced and fixed with catgut sutures which include only the soft parts. The deep recesses of the wound are then most thoroughly cleansed by irrigation with lot. hydr. perch. (1 in 4,000), iodoform, or glutol, carefully dusted in, and the chief cavities of the wound filled with packs of iodoform gauze, to check oozing. The gauze can be safely removed after three days. The patient's head and trunk are raised so that drainage may be facilitated. Drainage-tubes must be inserted at points where there is obstinate oozing, or pockets difficult of thorough cleansing.* A large rubber tube is passed into the bowel above the suture line to allow the escape of gas, and prevent distension of the bowel and strain upon the sutures.

The Management of Defæcation.—Here there is a divergence of opinion. The majority of surgeons have endeavoured to retard as long as possible the first action of the bowels. This, the bowels not acting till the sixth or eighth day, is facilitated by previously emptying them thoroughly (p. 780). Others have held that if the bowel can be brought down satisfactorily under the cut sacrum or into the perinæum, and the recesses of the wound kept plugged, an early action of the bowels will be safe and the formation of scybala avoided. Much must depend on the state of the patient as to flatulent distension, a condition which is very variable in different individuals.

(iii.) **Excision of the Rectum by the Vagina.**—This method was introduced by Norton,† and advocated by Camperon‡ and Rehn.§ More recently it has been successfully used and recommended for certain cases by Murphy and others. It is chiefly indicated when the

* I have no space to allude to the many modifications of Kraske's operation, parasacral, osteo-plastic, and others. As in many other operations, these modifications do not appear to me to be improvements. Moreover, most of them, owing to their additional severity, are quite unsuited to the patients who come to us with rectal cancer. Many of them are mentioned in a helpful article by Dr. A. G. Gerster (*Ann. of Surg.*, October, 1895, p. 485).

† *Trans. Chir. Soc.*, 1890.

‡ *France Médicale*, 1894.

§ *Cent. f. Chir.*, 1895, No. 10.

vaginal wall or uterus is adherent to the growth. The following description is based upon Tuttle's modification of Murphy's method.*

The patient is carefully prepared in the usual way, and placed in the lithotomy position with the pelvis slightly raised. The vagina is dilated with broad retractors. Unless the growth is very low down, the peritonæum must be opened, and this step greatly facilitates the liberation of the growth (*vide*, Fig. 327).

The cervix is drawn downwards and forwards with tenaculum

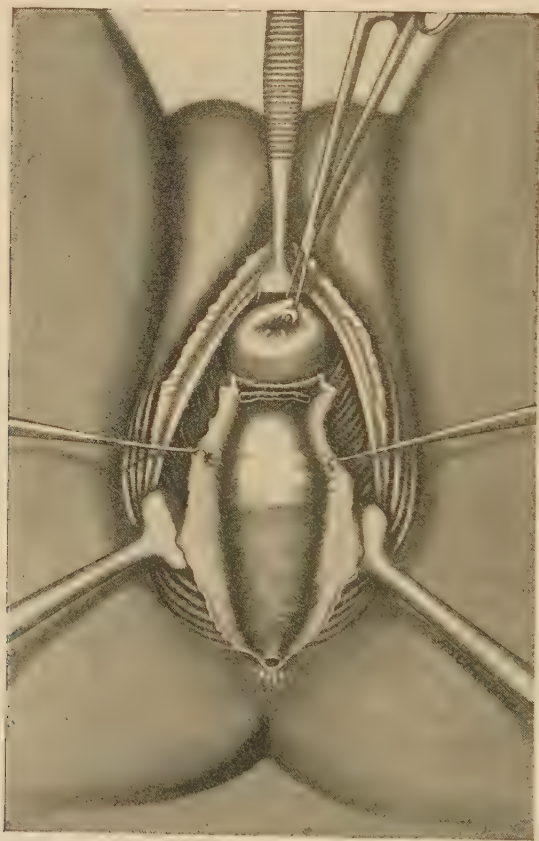


FIG. 327.—SEPARATION OF RECTUM FROM VAGINAL WALLS.
(Murphy).

forceps, and the pouch of Douglas opened transversely just below the cervical reflection, and the intestines packed away with gauze. A vertical incision is then made through the posterior vaginal wall in the middle line, extending from the first incision to the anal margin. The mucous membrane of the anal canal is isolated as in Whitehead's operation and ligatured to prevent any leakage during the later steps of the operation. The posterior vaginal wall is dissected off the rectum, great care being taken not to open the bowel. This accident is most

* Tuttle, *Diseases of the Rectum and Pelvic Colon*, 1903.

easily prevented by beginning the separation above at the peritonæal reflection. If any of the vaginal wall is involved, it must be sacrificed.

When the anterior surface of the rectum has been cleared, the lateral peritonæal reflections and the serous coverings of the meso-rectum are divided as already described (p. 785). Then the bowel can be more easily drawn forwards and downwards, while the posterior surface together with the lymphatic glands are separated from the sacrum by blunt dissection. If necessary, this dissection may be carried up as high as the promontory of the sacrum, in order to bring healthy bowel well above the growth, to the anal margin, without tension. To allow this, the superior hæmorrhoidal artery has to be tied and divided a little below the selected line of section of the bowel above the tumour. The rectum is then drawn down and the peritonæum closed by sutures or gauze packing, or both. When this essential step has been taken, the intestine is divided between two clamps at least one inch above the upper limit of the disease. When the growth has been removed, all bleeding vessels are secured, and the upper end of the bowel below the clamp forceps is sutured to the anal margin with numerous catgut or silk sutures.

In some cases it may be possible and wise to preserve some of the lower segment of the rectum, and to join the upper end to this, but the risk of leakage and infection of the wound is greater by this method, and it is therefore better to complete the operation after Moulounguet's method as described above, although this involves freer separation of the upper part of the bowel. In any case there must be no tension upon the sutures, and the blood supply must be satisfactory, or sloughing is bound to ensue.

The vaginal wall and the perinæum, including the external sphincter ani, are carefully sutured with catgut.

An incision may be made between the coccyx and the anus, and a drainage tube introduced through the pelvic floor into the hollow of the sacrum. This will be all the more necessary if end to end union above the levator ani has been adopted.

The results of the vaginal method have been good. Out of 23 cases collected by Tuttle only three died as the result of the operation (14·3 per cent.). The method is most suitable for growths low down and adherent to the vagina.

(iv.) **Excision of Rectum by Laparotomy.**—This mode of attacking rectal cancer is justifiable where the growth is situated very high up, at the junction of the rectum and sigmoid flexure, too high for the employment of the sacral route and too low to be reached by the far safer resection from the left iliac fossa (p. 388).

The bowels having been most thoroughly emptied, the bladder is emptied by a catheter, and the abdomen opened by a vertical incision passing through the left rectus abdominis and brought as low down as possible. The small intestines are then packed out of the way, and the growth, if possible, brought well up into view. Trendelenburg's position greatly facilitates this. If adhesions interfere with safe manipulation of the growth, the operation should be abandoned. If it is possible to proceed, the following steps are open to the surgeon: (A) To resect the growth, and to unite the ends with a large-sized Robson's bobbin (p. 374, Fig. 121) or Murphy's button (p. 368). If the bowels are empty, and if the patient's condition calls for speedy operating,

this position is one most favourable to the button. Every possible care must be taken with clamps and the assiduous use of gauze sponges to secure that no infection of the wound takes place. Another method, Maunsell's (p. 364), which has been successfully used for the removal of an intussusception (Hartley, *New York Med. Journ.*, Oct. 22, 1892), is also applicable to carcinomata.

(B) Paul suggests (*loc. supra cit.*) that in cases where the bowels are not emptied the safer plan would be "to double ligature, and divide

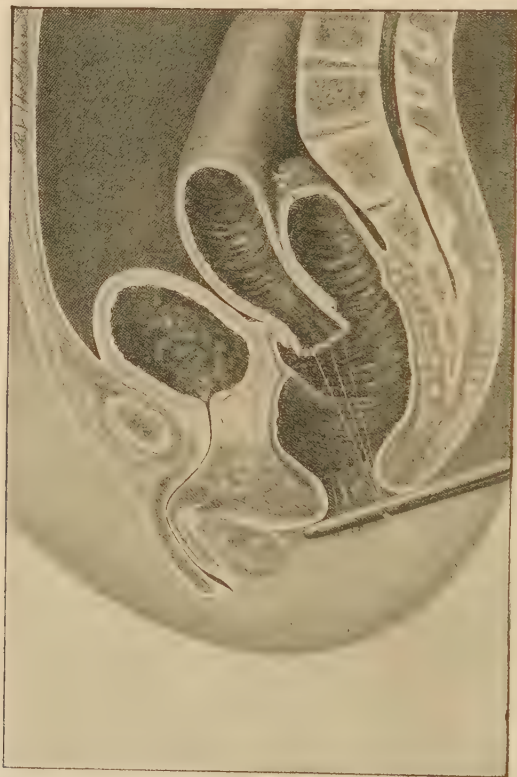


FIG. 328.—COLORECTOSTOMY (Kelly) OR INVAGINATION OF COLON THROUGH A SLIT IN THE ANTERIOR WALL OF THE RECTUM. (Tuttle).

the bowel above the growth, taking the upper end out through a small separate wound in the inguinal region, where subsequently a tube could be inserted and an artificial anus established. Then excise the diseased portion of the rectum, and invaginate and close the lower end." In some cases it may be possible after closing the lower end to bring the liberated lower part of the sigmoid through a vertical incision in the anterior wall of the rectum, after Kelly's method (Fig. 328). Retraction is prevented by sutures attached to the open end of the sigmoid and secured to forceps placed across the anus. The edges of the vertical incision in the anterior wall of the rectum become inverted, and wide serous apposition is thus secured. Tuttle found that narrowing of

the aperture occurred in one of his three cases; but the opening was easily enlarged through the anus.

(v.) **Excision of the Rectum by the Combined Methods.**—(A) *The Abdomino-perinæal Method.*—This plan, which is advocated by M. Quénu, of Paris, is thus described by Allingham (*Med. Ann.*, 1901, p. 464): "A preliminary sigmoidostomy is carried out some days beforehand. The belly is opened in the middle line, and both internal iliac arteries are ligatured. The already existing sigmoid anus is liberated, and the bowel is completely cut across with the thermo-cautery. The cut ends are cleansed and enveloped in iodoform gauze. The upper end is then brought out in the left iliac region, and constitutes the permanent anus. The lower end is freed by dividing the meso-sigmoid and meso-rectum along the entire length of the hollow of the sacrum. It is then packed with gauze at the lower part of the pelvis. The abdominal wound is closed. The patient is then placed in the lithotomy position, and the final steps of the operation are carried out from the perinæum. After plugging the anal canal, semilunar incisions are made on either side of the anus, the levatores ani are divided, the anterior wall of the rectum is carefully liberated, the pouch of Douglas is opened, the remaining connections are divided, and the diseased segment of bowel, along with the gauze stuffing in the pelvis, is brought out of the wound and removed. In two cases in which the author carried out the above operation successfully 'there was not the slightest shock'—a fact which was corroborated by M. Nélaton, who was present."

(B) **Abdomino-anal Operation.**—Maunsell (*Lancet*, Aug. 27, 1892, p. 473) through a median laparotomy wound freed the growth and the bowel above and below it. He placed a loop of tape round the rectum, then through a perforation in its anterior wall and out at the anus. By means of this tape the rectum was intussuscepted and the growth brought well outside the anus and removed, the bowel above and below being joined up by direct suture. Traction upon the tape is apt to enlarge the perforation in the rectal wall and to lead to leakage into the pelvis. Therefore Weir (*Journ. Amer. Med. Assoc.*, 1901, vol. ii. p. 801) modified Maunsell's method, as indicated in Figs. 329, 330. The superior hæmorrhoidal artery is tied near the promontory of the sacrum and the bowel loosened, tied and divided between the two lower tapes placed just above the levator ani (*vide* Fig. 329). The growth is then drawn out of the abdominal wound and excised. The lower segment of bowel is everted with forceps passed up from the anus. The healthy bowel is then drawn out through the everted tube and sutured as indicated in Fig. 330. The bowel is then allowed to retract, and a tube inserted in the pelvis through a wound in front of the coccyx, and another large tube is inserted through the anus, reaching above the suture line, so that the latter may be neither strained by distension of the bowel, nor contaminated with fæces before union has occurred. The abdominal wound is closed. The chief objections to this method are that it is a severe procedure, and that it is difficult to separate the bowel freely enough to allow the evagination described without interfering seriously with the blood supply. Further, the rectum is divided from within and deep down in the pelvis, where it is difficult to avoid contamination.

Sir Charles Ball in his instructive Erasmus Wilson lectures (*Brit. Med. Journ.*, 1903, vol. i. p. 540) advocated the more frequent adoption of the abdomino-anal method. An incision is made through the lower part of the left rectus, the Trendelenburg position adopted, the small intestine protected with gauze, and the sigmoid loop brought out and examined. The point at which the meso-sigmoid is longest is determined. The average length at this point is about six inches; and unless



FIG. 329.—ABDOMINO-ANAL EXTIRPATION OF HIGH RECTAL CANCER
—ENUCLEATION OF DISEASED PORTION THROUGH ABDOMINAL
ROUTE. (Tuttle).

it is shorter than this, the middle of the sigmoid loop can be brought down to the anus without tension. Under these circumstances the whole of the bowel below the middle of the sigmoid loop is extirpated, and the most mobile part of the sigmoid is brought to the anus, for it is more difficult to mobilise the lower end of the loop without seriously interfering with its blood supply. The line of section is therefore chosen without any regard to the position of the growth in the rectum, and this has the additional advantage of allowing a much freer removal of the meso-rectum and lymphatic glands. The bowel is divided at the middle of the sigmoid loop and between two ligatures.

The ends are cleansed and covered with gauze, which is tied round them to prevent soiling.

The meso-sigmoid is severed between clamp forceps, and the edges sutured or treated with the galvano-cautery. The superior hæmorrhoidal vessels are tied and divided as they run near the posterior border of the mesentery. The meso-rectum is divided close to the sacrum, and lower down the lateral and posterior peritonæal reflections are incised close to the rectum. The middle hæmorrhoidal vessels are secured as they run under cover of the lateral peritonæal reflections. By blunt dissection the bowel is then separated from the sacrum and coccyx as far as the pelvic diaphragm. Similarly the anterior surface is liberated from the bladder and prostate or vagina. This separation is generally easy in the cases of high growth to which this operation is suitable. When there are adhesions obliterating Douglas' pouch, however, considerable difficulty may be experienced in conducting the anterior separation in the proper plane, and in avoiding injury of the ureter and vagina. A firm ligature is placed below the disease at the lower end of the isolated part of the rectum close to the levator ani. The anus is then irrigated with an antiseptic solution by an assistant, and the bowel is divided below the ligature with a long-handled and curved pair of scissors. The growth is then free and is removed.

The lower end of the rectum is seized with forceps, everted, and its mucous membrane dissected off. The sigmoid is then drawn down, and its end is uncovered and sutured to the skin around the anus after the abdominal wound has been completely closed. A tube is passed into the bowel; and another one may be passed into the hollow of the sacrum through an incision made in the skin and pelvic floor in front of the coccyx.

In cases of growth of the upper part of the rectum, in which the meso-sigmoid is unusually short, Sir Charles Ball does not attempt to bring the bowel down to the anus, but prefers to avoid the risks of tension by making an artificial anus in the groin.

Miss Aldrich Blake in such a case (*Brit. Med. Journ.*, 1903, vol. ii. p. 1586) "straightened out the lower part of the sigmoid at its junction with the rectum" by incising the peritonæum to the left of the sigmoid, and close to the parietes, without injuring the vessels. A few careful snips in any position of the sigmoid meso-colon which seemed tight freed the flexure sufficiently to allow the lower part of the sigmoid to be brought

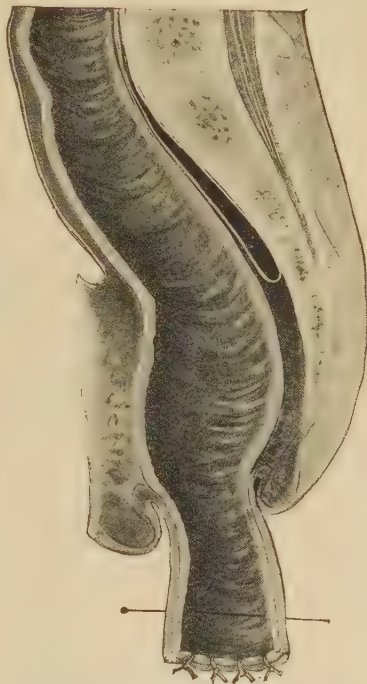
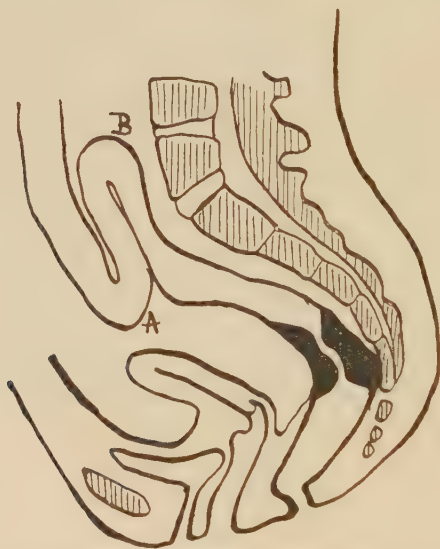


FIG. 330.—ABDOMINO-ANAL EXTIRPATION.

Sigmoid is brought down through everted rectum and sutured after method of Weir. (Tuttle).

down to the tip of the coccyx without tension. The rectum had been previously separated by blunt dissection down to pelvic diaphragm. The rectum and its mesentery, containing enlarged lymphatic glands, were pushed down to the pelvis, and the edges of the U-shaped incision in the pelvic peritonæum were sutured together so as to re-establish the pelvic pouch of peritonæum. The abdominal wound was completely closed by three layers of sutures. An incision was then made from the coccyx to the anus. The lower end of the bowel was liberated, and the rectum drawn out and divided at a point previously chosen and marked by a silk suture. The lower end of the sigmoid was then sutured to the anal mucous membrane about three-quarters of an inch above the cutaneous margin. No attempt was made to rejoin the posterior extremities of the sphincter ani, but the posterior wound was left freely open for

FIG. 331.



Abdomino-perineal excision of the rectum (Aldrich-Blake). A, dependent loop of sigmoid; B, end of sigmoid. The growth is shown lower down.

drainage. The patient was well in February, 1906, but with imperfect control over the anus, but "she has never had the sphincter operated on, as the bowels act so regularly that she did not consider the inconvenience sufficient to wish for further operation."

It is probably better to avoid dividing the posterior commissure of the anus and external sphincter, and to bring the lower end of the bowel if well nourished, as indicated by free bleeding from it, to the actual anal margin. If more room is required, and the sphincter has therefore to be divided, it can be joined up again, and the posterior end of the wound drained.

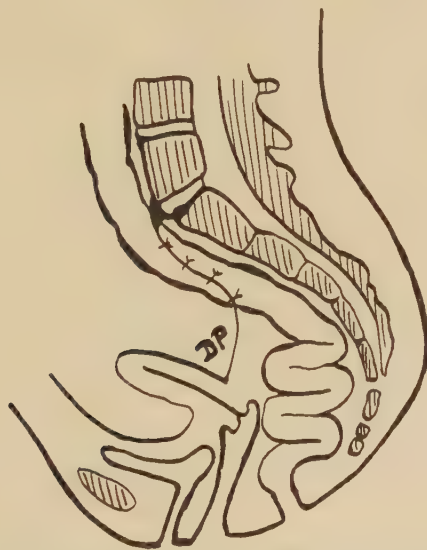
After-treatment.—The chief points here are to keep the wound sweet by frequent syringing with peroxide of hydrogen $\frac{1}{5}$, the careful insufflation of iodoform, and the keeping all pockets dry. The patient is kept in Fowler's semi-sitting attitude if possible to aid drainage. The catheter will probably be required, and a mild aperient may be given about the sixth day, if needed. The finger

should be occasionally passed with the utmost gentleness, and after a week or ten days a bougie or vulcanite tube.

Causes of Trouble and Failure after Excision of the Rectum.—

1. Shock.
2. Hæmorrhage.* This will rarely be difficult to deal with at the time, or met with later, if the surgeon has plenty of Spencer Wells's forceps, good assistants, and, if he does the operation, methodically takes care to secure the vessels high up and to work from above downwards as far as possible. Gauze packing is also very valuable in arresting both primary and secondary hæmorrhage in these cases.
3. Suppuration, cellulitis, and other septic troubles.
4. These, which cause 75 per cent. of the fatalities, can be largely

FIG. 332.



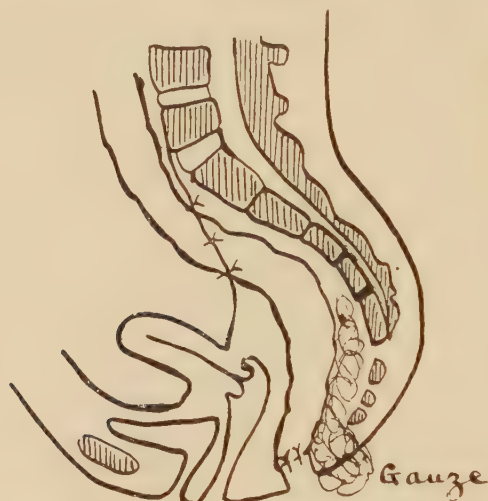
Abdomino-perineal excision of the rectum (Aldrich-Blake). The greater part of the rectum has been freed by abdominal section, the angle of union of the sigmoid having been straightened out so that the end of the sigmoid can be brought to the anal canal. The unopened bowel containing the growth, and the meso-rectum have been pushed down into the pelvis, the pelvic peritoneum sutured, and the abdomen closed.

prevented by carefully carrying out the preliminary treatment, and by preventing as far as possible any leakage from within the bowel into the wound during and after the operation. 5. Gangrene of the stump of the bowel from over-interference with its blood supply or retraction of the superior hæmorrhoidal artery (Morestin, quoted by A. G. Gerster, *loc. supra cit.*, *Gaz. des. Hôp.*, 1894, p. 326). To avoid this care must be taken to preserve the blood supply of the upper segment, and to see that its cut surface bleeds freely before it is joined. Moreover, tension is to be avoided, and it is preferable

* Mr. Cripps has shown that, as most of the bleeding comes from vessels situated in the walls of the rectum, dragging down the bowel with a firm grasp will not only greatly facilitate the operation, but also prevent hæmorrhage.

not to join tissues which are upon the stretch. 6. Exhaustion. 7. Recurrence. Freer excisions are required to lessen the frequency of this. 8. Sacral fistula. This may be *primary* from defective sutures of the bowel, or *secondary* from the formation of (9) a stricture after resection.* 10. If the fistula does not close it must be submitted to a plastic operation. 11. Prolapsus. This may date to the operation, or to straining afterwards and yielding or bursting of the scar. This

FIG. 333.



Abdomino-perineal excision of the rectum (Aldrich-Blake). The lower extremity of the rectum has been isolated through a perineal incision, and the growth removed. The lower end of the sigmoid has been sutured to the anal canal and the posterior end of the wound drained with gauze.

tendency will be met by the use of Mr. Paul's truss or one like it (p. 800). When it occurs in the perineum a modified Whitehead's operation may be performed for its removal.

IMPERFORATE ANUS.—ATRESIA ANI.—IMPERFECTLY DEVELOPED RECTUM (Figs. 334—340).

A surgeon, when called upon to explore these cases, will do well to bear in mind the following natural and practical classification, because on this depends his treatment:—

Two Main Varieties: A. Cases in which no normal anus exists—**Imperforate Anus.** B. Cases in which a normal anus exists, but the gut is obstructed higher up, or undeveloped—**Imperforate Rectum.**

A. Imperforate Anus. 1. Anus partially closed—(a) by adhesions of epithelial surfaces, as occasionally happens in the labia of a female

* A. G. Gerster (*loc. supra cit.*) holds that resection has been invariably followed by a stricture, no matter what form of approximation—suture, Murphy's button, or invagination—is used. Frequent digital examination is indispensable. The stricture, if detected early, will yield to systematic dilatation with a bougie.

infant; (b) by a membrane. 2. Anus completely closed, but only by a membrane. 3. Anus completely closed by a membrane, but a fistula exists—(a) on the surface of the body (*e.g.*, the *raphé* of the scrotum); (b) into the vagina (Fig. 335); (c) into the urethra or bladder (Figs. 336, 340). 4. Anus imperforate and the rectum deficient as well.

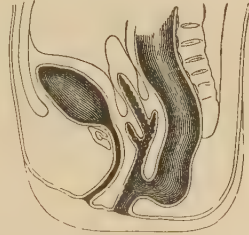
B. *Anus in Natural Position, but the rectum is deficient.** (a) The

FIG. 334.†



Anus absent, rectum opening by fistula, close to urethra. (Rushton Parker.)

FIG. 335.



Anus absent, rectum communicating with vagina. (Rushton Parker.)

rectum is deficient for a short distance only, and separated from the anus by a *cul-de-sac* (Fig. 338); (b) the rectum is deficient for a long distance, or entirely (Fig. 339).

Treatment. A.—Those in which no natural anus exists.

1 and 2. If the atresia be due to epithelial adhesions, or to a more or less complete membrane, the former should be broken down and the latter snipped away with scissors, and the opening kept patent by a small piece of oiled lint, the nurse's little finger being introduced twice daily.

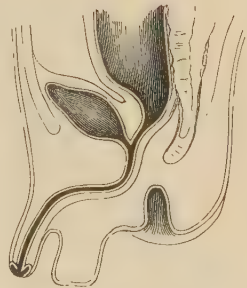
3. If the anus be imperforate and the fistula open (a) on the surface of the body, (b) into the vagina, or (c) urethra.

(a) A probe is passed from the skin-fistula (*e.g.*, in the scrotum) towards the proper anal site; it is then cut down upon and the opening established in the proper position.

(b) If the fistula open into the vagina, the treatment will vary somewhat with the urgency of the case, the size of the opening, and the age of the child.

Thus if the opening be very small, and the retention urgent, a silver director should be passed through the vaginal fistula back to the proper site of the anus, and there cut down upon. If the bowel is

FIG. 336.



Anus ending in a *cul-de-sac*, rectum opening into urethra far back. A case for Littre's operation. (Rushton Parker.)

* As Mr. Holmes has shown, these cases are important, as they are liable to be overlooked till considerable distension has taken place.

† This and the next six figures are taken, with a few alterations, from an article by Mr. Rushton Parker (*Liverpool Med. Chron.*, July, 1883).

within reach, it should be drawn down and stitched *in situ*. The orifice should be kept patent.

In such a case, though an anus is established in the proper position, it is very doubtful if the vaginal fistula will close, and a further operation will probably be required later on. Plastic operations should not

FIG. 337.



Anus absent. Rectum could be reached by dissection. (Rushton Parker.)

FIG. 338.



Anus ending in *cul-de-sac*. Rectum readily reached from this. (Rushton Parker.)

be tried too early, on account of the softness of the tissues and the liquid condition of the *fæces*.

If, owing to the size of the vaginal fistula, there be not much retention, and especially if the child be not very young, the following operation may be performed, after the method of Rizzoli, quoted by

FIG. 339.



Anus absent, rectum ending high up. A case for Littre's operation. (Rushton Parker.)

FIG. 340.



Anus and rectum deficient, the bowel ending in the bladder. (Rushton Parker.)

Mr. Holmes, *Syst. of Surg.*, vol. iii. p. 788. An incision is made from the vulva to the coccyx in the middle line, the rectum found by most careful dissection, separated from the vagina, and then brought down and fixed in its natural position. To aid in finding the rectum, a probe should be passed from the fistula.

After the rectum has been brought down and secured the incision between the anus and vulva is united to form a new perinæum.

(c) Fistula into the urethra or bladder. Two questions here arise: How high up is the communication? How much of the bowel is deficient?

If the perinæum seems fairly developed, if the ischial tuberosities are not in close contact, if any bulging can be detected at the natural site of the anus, the communication is probably recto-urethral, and an attempt may reasonably be made to find the bowel from the perinæum. If it is found, and can be brought down, an attempt may be made to separate it from the adjacent urethra, but usually the surgeon will have to be satisfied with a free opening, and with keeping this patent, so as to encourage the urethral communication to close. If there appear no probability of the bowel being within reach, or if this cannot be found, Littre's operation should be performed (p. 128). If the child survive, the bladder must be kept carefully washed out if any fæces still find their way into it. Thus, in a case of Mr. Clutton's (*St. Thomas's Hosp. Rep.*, vol. xi. p. 84), a child about a month old died, sixteen days after Littre's operation, of suppurating kidneys, due to the offensive purulent urine.

4. Anus absent and rectum deficient as well. Here the chief question is how far upwards an exploratory operation may be safely conducted.

External evidence. Genitals far back and close to the coccyx, and ischial tuberosities close together, point to absence of the rectum.

In most cases the surgeon begins by exploring. The child being under the A.C.E. mixture and in lithotomy position, and a small sand-bag placed under the sacrum, and the bladder emptied with a catheter, the surgeon, seated at a comfortable level, makes a free incision from the position of the anus back to the coccyx. Keeping exactly in the middle line, and opening up the cellular tissue with his finger-tip, aided by a scalpel and director, the surgeon works backwards towards the concavity of the sacrum, constantly taking note with his finger-tip of the depth to which he has got, while an assistant aids in bringing down the bowel by supra-pubic pressure.

As a rule, two inches are a sufficient depth in a new-born child. If still in doubt whether to proceed or no, the surgeon may make a careful puncture with a morphia-syringe backwards, and note the condition of the point. No puncture with a trocar is justifiable at this depth.

Points to bear in mind.—1. The rectum may end at the brim of the pelvis. 2. If it end lower down, it may be floating with a long mesorectum. 3. Though the rectum may end within reach, the peritonæum may, and not infrequently does, extend low down on the bowel. 4. Even if the rectum is successfully opened high up without opening the peritonæum, fatal cellulitis may be set up by the escaping fæces, or by the attempts to keep the bowel patent.

If the above exploratory operation fail, inguinal colotomy or Littre's operation should be resorted to (p. 128).

B. Imperforate Rectum.—The treatment here will be an exploratory perinæal operation, followed, in case of failure, by Littre's operation (p. 128), but in some cases the colon may be found empty or represented only by a fibrous cord. In such cases, the small intestine must be drained as low down as possible.

CHAPTER XVI.

RUPTURED PERINÆUM (Figs. 341, 342).

THE following account is taken from my colleague Dr. Galabin*:

A. **Operation for Partial Rupture** (Fig. 341).—The patient is placed in lithotomy position. The need for assistants to support the thighs is avoided if a “Clover’s crutch” is used.

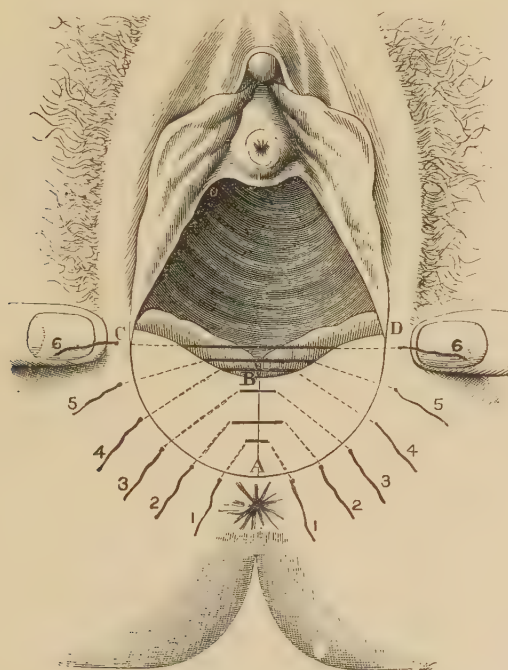
“The extent of surface to be freshened is indicated, to some extent, by the cicatrix left by the rupture. It is well, however, to go a little beyond the limits of this in all directions, especially up the median line of the vagina and towards the lower halves of the labia majora, both in order to secure, if possible, a perinæal body somewhat larger and deeper than the original one, and to allow some margin, in case the surfaces do not unite completely up to the edges. To put the mucous membrane on the stretch, an assistant at each side places one or two fingers on the skin of the thigh and draws the vulva outwards (Fig. 341). The skin just beneath A, in front of the anus, may also be seized by a tenaculum and drawn downwards. If still the mucous membrane is not sufficiently on the stretch, from laxity of the vagina, the posterior vaginal wall, some distance above B, should be seized by a vulsellum and pushed upwards. Incisions are then made through the mucous membrane from B to A, in the median line of the vagina, and from A to C and D through the junction of mucous membrane and skin. These should not be extended in the direction of C and D farther than the lower extremity of the nymphæ at the utmost. There are then two triangular flaps, ABC and ABD. These are to be dissected up from the apex A towards the base BC and BD, the corner of the mucous membrane at A being seized with dissecting forceps. The dissection should not be deeper than necessary, and if it is done with the knife the surfaces are more ready to unite. If, however, there is much tendency to bleed, scissors may be used. The apices of the flaps are then cut off with scissors, leaving an upturned border along BC and BD. When the surfaces are drawn together these borders form a slightly elevated ridge towards the vagina, and if there is any failure of union just along the edge they fall over and cover it.

“Silkworm-gut sutures are then placed as shown in the figure by means of Hagedorn’s needles of half-circle curve. Another mode is to bury the sutures, 1, 2, and 3, in the tissues throughout their whole course. If, however, they are brought out in the centre for spaces alternately short and long (Fig. 341), the surfaces are more easily brought into contact at all levels without undue tension. In passing

* *Diseases of Women*, 1903, p. 618. Anyone making trial of this method will agree with me as to its simplicity and excellent results.

sutures 4, 5, 6, the needle should be brought out precisely on the margin along which the border of mucous membrane BD is turned up from the vagina, not passing through the mucous membrane itself, and passed in again on the corresponding spot on the margin BC, to be brought out so as to include the skin of the perinæum. The sutures are then tied in the order of the numbers 1 to 6, care being taken that the surfaces are brought just sufficiently into apposition, and that no clots of blood are left between them. The bleeding, if any continues, is arrested by bringing the surfaces together, and if they are properly united there will be no secondary hæmorrhage, unless the sutures begin

FIG. 341.



(Galabin.)

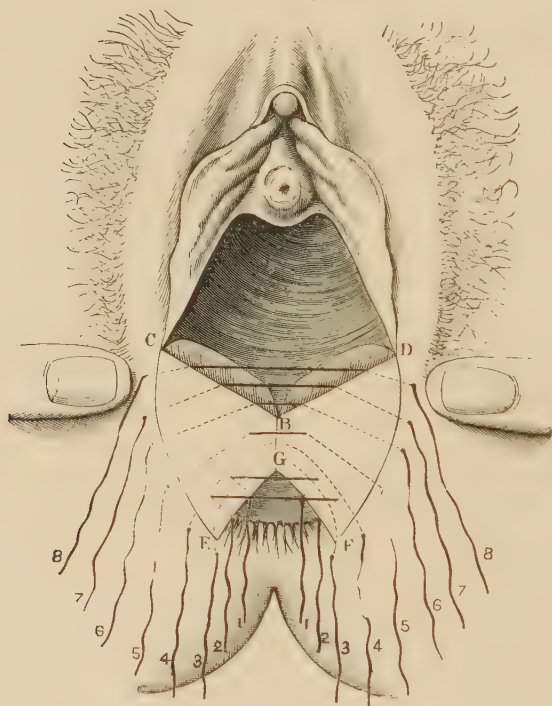
to cut from excessive tension. The sutures may be left in from seven to nine days."

Operation for Complete Rupture (Fig. 342).—A sponge tied by a tape is passed into the bowel, and preliminary steps are taken as above. "A point B in the median line of the vagina, a sufficient distance above the apex of the rent in the septum, is taken, and an incision through the mucous membrane is made from B to G and from G to E and F along the edges of the septum, between the rectal mucous membrane and the cicatrix. Incisions are also made through the skin from E to C and F to D, so that the freshened surface may extend somewhat beyond the limits of the cicatrix left by the rent, C and D not to be higher than the lower extremities of the nymphæ. The quadrilateral flap EGBC is then seized at E by dissecting forceps, and dissected up with the knife from the angle E, and afterwards from the angle G,

towards the base BC. While this is done, the parts are kept on the stretch by an assistant drawing down the skin below E with a tenaculum. The flap is then cut away with scissors, except an upturned border, which is left along BC. The flap FGBD is treated in a similar manner. If, as is usual, the ends of the sphincter at E and F have retracted from the margin of the cicatrix, it is well to cut away with the scissors a narrow strip of rectal mucous membrane, generally somewhat everted, a short distance from E and F towards G, so as to bring the freshened surface to the ends of the sphincter.

"Sutures are then applied in the following manner: First, rectal

FIG. 342.



(Galabin.)

sutures of chromic gut, either two or three, according to the extent of the rent in the septum, are applied. These are destined to be tied in the rectum, and left to be absorbed, the ends being cut short. They are best applied with Hagedorn's needle holder and needle. The needle is passed in a little distance from the margin of the rent, and brought out almost at the very edge of the rectal mucous membrane, on the line GF. The needle is then threaded at the other end of the suture, and that is drawn through in the same way from without inwards, emerging on the margin EG. The remaining sutures should be of stout fishing-gut. One or two sutures may be first passed completely round through the remnant of the septum by means of a Hagedorn's needle. The first of these (3, Fig. 342) is passed in somewhat behind and below the angle F, so as to take up, if possible,

or at least go quite close to, the end of the divided sphincter, and is brought out in a similar position near E. Thus, when tightened, it brings together the ends of the sphincter, drawing it into a circle; but it often brings into apposition, not so much the freshened surfaces above as the unfreshened rectal mucous membrane. This serves as a barrier to keep out fæcal matter, while the next suture (4, Fig. 342) aids the rectal sutures in uniting the freshened surfaces. The remaining sutures are passed as shown in the figure (5—8, Fig. 342) by a Hagedorn's needle, in the same way as in the operation for incomplete rupture. The needle is passed in pretty close to the edge CE or FD, and is brought out (except in the case of suture 5, Fig. 342) on the line where the margin CB or DB is turned up. On the opposite side it is passed in a similar way from within outwards. The effect is, that when the sutures are tightened the margins BC, BD, are turned up into a slight ridge towards the vagina, and afterwards fall over and cover any portion of the vaginal border which does not unite quite up to the edge. Suture 5 (Fig. 342) may either be buried throughout, or brought out for a very short space near the median line BG.

"When all the sutures are in place, the sponge is withdrawn from the rectum, and the rectal sutures are tied first. Care must be taken to draw up the whole of the slack in the centre, and bring the edges EG, FG, perfectly together. This will approximate the ends of the sphincter to a great extent, and the approximation is completed by tightening suture 3. The remaining sutures are then tied in the order of the numbers, care being taken to allow no clots of blood to remain between, and to tighten them just enough to bring the surfaces in contact. The ends of each perinæal suture should be tied together, and left rather long, so as to be less likely to prick the skin. After three clear days an action of the bowels is obtained by a dose of an ounce of castor oil. Enemata should be avoided if possible, but may be necessary if a collection of fæces has formed in the rectum. Special care must be taken that no collection of hard fæces takes place for the first two or three days after removal of the sutures.

"The perinæal sutures are removed in seven or eight days.

"In some cases, by the primary operation after labour, only superficial union is secured, and a recto-vaginal fistula is left close to the part united. The best plan is then to cut through the bridge of union with scissors at the time of the operation, and then proceed as in the case of complete rupture. This is the only way to secure a firm and thick perinæum, and is less likely to fail than an operation on the fistula alone."

CHAPTER XVII.

OPERATIONS ON THE OVARY.

OVARIOTOMY.

ONE or two practical points will be alluded to before the operation is described.

Date of Operation.—An ovarian tumour should be removed as soon as possible after its discovery. For by delay not only is the patient subjected to the risk of accidents in connection with the tumour itself, but her general health is likely to suffer from the effects of pressure on neighbouring organs.

Accidents in connection with Tumour.—The accidents to which an ovarian tumour is liable should be borne in mind. They are, shortly, as follows :—

(1) *Inflammatory Changes.*—These, whether confined to the peritonæal covering or dependent upon inflammatory and necrotic changes in the cyst itself, will lead to adhesions between the tumour and the abdominal wall or viscera. When recent these adhesions may readily be separated, but when old and fibrous they may lead to serious difficulties in the course of the operation. The contents of the cyst may suppurate, and, fouling the peritonæal cavity, lead to suppurative peritonitis.

(2) *Torsion of the Pedicle.*—When slowly produced, the interference with the blood-supply to the tumour will set up necrosis and so render the cyst wall liable to rupture. Acute torsion will lead to bleeding, which may be so profuse as to rupture the cyst wall and endanger the patient's life. Under these circumstances an immediate operation is called for, with all the disadvantages that an operation of urgency entails.

(3) *Rupture of the Cyst.*—This may, as has been mentioned, follow necrotic changes in the cyst or torsion of the pedicle. It may, in addition, depend merely upon thinness of the wall or upon weakening due to the extension of growth from the interior through the cyst-wall. As a result the contents become disseminated through the peritonæal cavity, setting up peritonitis in certain cases, or leading to a general infection of the peritonæum with secondary growths in others.

(4) *Malignancy.*—We have, finally, to remember this important practical point, that it is difficult at an early stage to say whether we are dealing with a malignant growth or not. It is especially in children that an early removal is demanded, for in them the proportion of malignant tumours is much higher than in adults. Mr. Bland Sutton

found 21 cases of sarcoma in a series of 100 ovariectomies performed in girls under the age of 15 (*Surgical Diseases of the Ovaries and Fallopian Tubes*, 1896, p. 178).

General Condition of the Patient.—The condition of the viscera, kidney, lungs, &c., the habits of the patient, her digestive powers, must all be carefully noted. For upon a consideration of these points not only does the prognosis to some extent depend, but also the nature and duration of the treatment to be adopted preparatory to the operation. Age need not be regarded as a bar to operation. Mr. Bland Sutton has collected 11 cases of ovariectomy in women over 80, all of whom recovered (Bland Sutton, *loc. cit.*, p. 175). The presence of albumen in the urine should not be regarded as necessarily a contra-indication to operation. Small amounts often clear up after the removal of the tumour. If chronic nephritis is known to be present, the operation should still be carried out, in most cases, after suitable preliminary treatment.

As regards difficulties likely to be met with in the course of the operation, some information will be obtained from the history of the patient and from careful examination. Attacks of pain will point to peritonitis and adhesions. An examination of the tumour will give some idea of its mobility, of the proportion of solid matter, &c.

The *amount of skill of the surgeon*, though a delicate matter, must also be mentioned. No one should operate on these cases who has not had good opportunities of seeing others operate frequently, and no one should undertake a case whose ovariectomies are, at the most, likely to be but two or three in his lifetime.

Preparation of the Patient.—The patient should be kept quiet for two or three days before the operation in an ordinary uncomplicated case, and the bowels regulated. The diet need not be unduly restricted or altered beyond seeing that it is easily digestible and nutritious. One or two warm baths may be taken for a day or two before the operation. On the evening preceding the operation the abdomen should be thoroughly washed, attention being paid particularly to the navel. It is better, especially in a delicate, sensitive patient, to defer the shaving of the pubes until she is under the anæsthetic. A compress of 1 in 2000 perchloride of mercury should then be applied. A purge should be given overnight, followed by an enema in the morning. On the day of operation a light breakfast should be taken, and some beef-tea or soup about 10, if the operation is to take place about 2 p.m. When the patient, warmly clad, especially as to her extremities, comes in to take an anæsthetic, only two or three faces that are familiar to her should be present; when she is under the anæsthetic, a catheter should be passed, if the bladder has not been emptied beforehand.

Preparation of Instruments, &c.—The room, which has been thoroughly cleansed, and not rendered too comfortless for the sake of ventilation, &c., should have a temperature of about 65°. A good light, and one likely to last, should be secured. The table should be sufficiently high to save the operator stooping, and only just wide enough to hold the patient comfortably. It will be found an advantage to have a table which allows of the patient being placed in the Trendelenburg, or raised pelvic, position, if necessary. A dozen new Turkey sponges,

chosen for their even softness of texture, should have been carefully prepared, and four flat ones (not too large) should also be provided. A few small sponges, ready for use on holders, leave no excuse for the dividing of sponges during the operation, a course to be unhesitatingly condemned. Instead of sponges, gauze swabs and pads are more generally employed; these must, of course, be provided in larger numbers, as they cannot be cleansed after use; they must be carefully counted before and after the operation.

The following should be in readiness: two scalpels, steel director, twelve pairs of Spencer Wells's forceps at least, cyst forceps, Spencer Wells's vulsellum-trocar and tubing and a simple curved trocar and canula, blunt-pointed scissors, needles (long straight ones to be threaded with silkworm gut for closing the abdominal wound, and fine ones, both straight and curved, for underrunning any bleeding point or introducing fine sutures if any of the contents of the abdomen are unavoidably injured), two aneurysm-needles, pedicle needle, needle holder, two retractors, sponge holders, plenty of silk and chromic-gut ligatures of varying sizes (and the material carefully prepared, including some stout enough for the pedicle), two pairs of dissecting forceps, dressing forceps, drainage tubes (both glass and rubber), abundance of lysol and mercury perchloride lotion, a foot-pan to stand under the table, two others to wash the sponges in, and a laryngeal mirror or electric lamp. The instruments should stand, in two trays or pie-dishes, on a small wheel-table close to the operator's right hand. The ligatures and sutures should be in separate porringers, all covered with carbolic acid (1 in 40) or lysol.

In addition to the anæsthetist two assistants will be found amply sufficient, one to stand opposite the operator to assist in securing vessels, to help with the tumour, &c., whilst the second will hand instruments, thread needles, prepare ligatures, and so on. One nurse will be required to wash sponges if these are used, and another to attend to the nursing operations generally.

The Operation.

Incision of Abdominal Wall.—An incision in the median line, reaching from just below the umbilicus to within two inches of the pubes, is made through skin and fat. There is no object in having the incision more than four inches long to commence with, as it can be lengthened as required subsequently. After dividing the skin and fat, the layer of fascia which forms the sheath of the recti muscles comes into view. If the muscles are in apposition, one or both of them will be exposed on incising the fascia; the interval between them should be sought for, and the two muscles separated for the length of the incision. If the linea alba is missed, and a difficulty is experienced in finding the median line, a director or the handle of the scalpel should be introduced beneath the fascia; the director will be arrested on the side on which the linea alba lies.

If the recti are separated, an incision through the fascia in the median line at once exposes the sub-peritonæal fat and peritonæum. Before this is incised Spencer Wells's forceps are applied to every bleeding point; these may be left on until the operation is concluded; any bleeding points then persisting should be treated by torsion, and not by ligatures, as these latter weaken the cicatrix. The peritonæum,

readily recognised, when healthy, by its delicate fasciculation and translucency, is carefully picked up by a pair of forceps so as to include nothing else, and an incision is made in it horizontally with a knife. As soon as the peritonæal cavity is opened the intestines fall away from the abdominal wall. The peritonæum is then slit up on two fingers for the length of the incision; the fingers, used in this way as a director, are enabled to detect the height to which the bladder comes at the lower part of the wound, and so determine the limit to which the peritonæal incision may safely be carried below.

Mr. Doran (*Ann. of Surg.*, May, 1888) thinks a mistake is often made in not bringing the incision near enough to the pubes, which may cause much trouble when the pedicle has to be drawn out, and greatly impede a thorough exploration of the pelvis.

Care should be taken not to mistake the sub-peritonæal fat for omentum, as this may lead to extensive stripping off of the peritonæum from the abdominal wall, an accident likely to be followed by sloughing of this structure.

In an easy case without parietal adhesions the pearly glistening cyst comes into view as soon as the peritonæum is incised; but if the peritonæum is thickened and adherent to the cyst there may be the greatest difficulty in deciding when this is reached, and the incision may even be carried through the cyst wall. In cases of difficulty the incision should be prolonged upwards to the left of the umbilicus until a spot free from adhesions is found.

When the tumour is exposed it should be examined carefully by eye and hand. Its nature should be noted, whether cystic or solid, or partially solid, whether a dermoid or inflamed; the presence of adhesions should be ascertained, or secondary malignant deposits, rendering further operation inadvisable. If we are dealing with an uncomplicated cystic tumour of the ovary, the first proceeding is to tap it. To separate adhesions before tapping is, in Mr. Thornton's words (*Dict. of Surg.*, vol. ii. p. 153), "bad practice, because, if they are separated while the parietes and cyst wall are both stretched by the fluid, all the little vessels in them bleed, and very serious hæmorrhage may occur out of sight during the subsequent emptying of the cyst, whereas, if the cyst be first tapped, the contraction of both parietes and cyst wall closes the smaller vessels."

Emptying the Cyst.—The abdominal incision should be packed round to prevent fluid running back into the abdominal cavity. The cyst is next tapped by carefully plunging in a Spencer Wells's trocar, then guarding the point with the inner tube, and as soon as the walls of the cyst are rendered lax enough by the escape of the contents attaching the claws to the cyst wall, so as to keep this on the trocar, as forward traction is made.

Dr. Baldy (*Syst. of Gynæcol.*, 1894) points out that the puncture should not be made at the lower angle of the wound, for the reason that as the cyst empties it retracts, and leaves the opening situated below the wound, increasing the difficulty of preventing fluid from entering the peritonæal cavity. As soon as the trocar is inserted into the cyst, the assistant should place a hand low down on each side of the abdomen, and press steadily and firmly. By this means he not only forces out the fluid from the cyst, but keeps the abdominal incision

taut over the tumour, thus preventing the contents of the cyst from running into the peritonæal cavity. As the cyst empties traction is applied to it by means of the claws of the trocar or by other forceps, and if there are no adhesions it is readily brought out of the wound.

If there is difficulty in delivering the tumour, and it is clear, from the bulk of the cyst remaining after tapping, that it is multilocular or solid, it will have to be further reduced in size before extraction. If it is multilocular, it must be tapped again in two or three more places by removing the trocar and closing the puncture with cyst forceps, and then, while the cyst is dragged forward and steadied, the first trocar or a smaller one is thrust in at other spots where fluid is still present. This is a better practice than thrusting the trocar from the first puncture into other parts of the cyst in the dark. If this latter method is adopted, the hand should first be passed into the abdomen to make sure that the trocar does not perforate the cyst wall and injure the viscera. In cases in which the tumour is composed of a large number of small cysts, or in which the contents are so viscid that they will not escape through the trocar, the opening should be enlarged and the hand passed into the cyst to break down the numerous septa or scoop out the viscid contents.

If the bulk of the cyst is solid, the trocar puncture having been enlarged and clamp forceps firmly keeping forward the edges, the surgeon first introduces two or three, then, perhaps, all the fingers of one hand, and scoops out the solid material till the bulk of the cyst is sufficiently reduced to come through his incision. It is preferable, however, to enlarge the incision upwards sufficiently to allow of the mass being brought out entire, its long axis being tilted into that of the wound. In these cases it is especially important to avoid any leakage of the contents into the peritonæal cavity, as portions of the tumour thus carried in may give rise to a recurrence of growth.

If the wound requires enlargement, this is best done with a blunt-pointed straight bistoury or a pair of scissors and the use of two fingers as a director, the incision being carried to the left of the umbilicus so as to avoid any still open vessel in the round ligament.

The enlargement of the wound may be found necessary when the ovarian tumour is solid or contains such a proportion of solid material as to render its delivery through the original incision difficult. When feasible, this is a better plan in the latter case than scooping out the contents, as this proceeding is often attended with considerable hæmorrhage, and is, moreover, likely to be followed by reinfection of the peritonæal cavity. The wound should be enlarged when, from the previous history or the appearance of the tumour, there is reason to believe that suppuration has occurred. Many surgeons prefer to remove dermoids, unless of large size, entire, to obviate the risk of the oily contents escaping into the abdominal cavity.

Treatment of Adhesions.—As the cyst is emptied and drawn forwards, any adhesions that are present must be dealt with, and the ease with which they are separated will depend upon whether they are recent or not. Those between the tumour and abdominal wall are readily separated, when recent, by sweeping the hand between the two adherent surfaces. If of longer duration the separation must be effected, bit by bit, with the finger-nail or scissors, any persistent

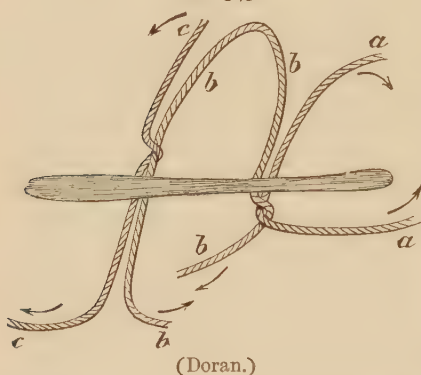
bleeding points being secured by Spencer Wells's forceps and tied. Another method is to under-run any bleeding points, especially any obstinate ones in the parietal peritonæum. Adhesions to the omentum, which are the most common, must be ligatured and divided, the number of ligatures used depending on the extent of the adherent omentum, Mr. Herman (*Diseases of Women*, 1898, p. 797) points out that holes frequently exist in large pieces of adherent omentum, and he advises that in cutting the omentum away the incisions should be carried through these holes to obviate any subsequent risk of intestines being strangulated in them. Intestinal and other visceral adhesions may present considerable difficulties. If the bowel is adherent it should be very carefully peeled by means of the thumb-nail from the cyst. If it cannot be detached in this way a thin strip of the cyst wall should be cut away and left adherent to the intestines. Firm adhesions in the pelvis present the most difficulty, and in the separation of them by means of the fingers a hole may be torn in the rectum. Injury to large vessels is not common. In Dr. Baldy's *Gynæcology*, however, a case is recorded in which death resulted from hæmorrhage due to injury of a large vein in the removal of an ovarian cyst. Though bleeding from large vessels is not common, it is especially in cases of extensive pelvic adhesions that we get troublesome oozing. Temporary plugging with sterilised gauze may arrest this, but should it fail, an attempt should be made to seize the bleeding points with forceps and secure them with ligatures. This procedure will be much facilitated by having the patient in the raised pelvis position. If bleeding cannot be arrested by these means the pelvic cavity should be firmly packed with long strips of sterilised or iodoform gauze, the ends of which are brought out through the lower part of the wound. The sutures should be introduced as usual into the lower part of the abdominal incision, but should be left untied, ready to bring the edges of the wound together when the plug is removed. The gauze should be taken out forty-eight hours after the operation. By that time it will have served its purpose, the arrest of the oozing. It will be found that the plug is more easily removed then than later, though some operators recommend that it should be left in a week. This method of treatment by packing is a much more reliable and, on the whole, safer method than the older ones of cauterisation or touching with solid perchloride of iron. If packing with gauze is used for troublesome pelvic oozing, the cautery will be very seldom required. Mr. Herman, who has never had occasion to use the cautery, says with regard to its employment in the pelvis: "Large vessels lie so close under the peritonæum that I should fear to burn extensively in this region." With regard to the use of iron perchloride, the only condition that demands its use, viz., general oozing, is better met by the use of the gauze tampon.

Treatment of Pedicle.—When the cyst has been sufficiently brought outside, the pedicle is dealt with.

The centre of the pedicle being found by unfolding it, a blunt pedicle needle loaded with silk (No. 4) is made to perforate it here at a spot devoid of vessels. The loop of silk being drawn through and the needle withdrawn, the loop is cut, and the two ligatures tied firmly round the two halves of the pedicle. To make the silk hold in a stout

pedicle, it is well to loop the ligatures round some blunt instruments, so as to tie them with sufficient force. When they are both tied, one is cut short while the other is thrown round the whole pedicle and tied again. The cyst is then cut away, not more than three-quarters of an inch and not less than half an inch, from the ligatures. When this is done, the cut end is carefully examined, to make sure that no bleeding is taking place. The pedicle is then allowed to drop in, and the finger, following it down to the uterus, finds and hooks up the other ovary. If

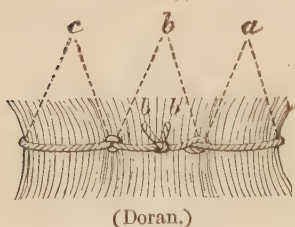
FIG. 343.



this is found enlarged it must be removed. When the pedicle is very broad, a second or a third transfixion will be needed. The second must be thus performed: The thread for the outer loop (a, Fig. 343) is twisted on one side of the pedicle round the outer thread (b); then the outer loop is tied. The pedicle-needle (a long unhandled one with a large eye is the best) is then threaded, first with a single ligature (c), and then with one end (b) of the untied thread already passed through the pedicle. The

transfixion is then performed (Fig. 343). The third thread (c) must be once twisted around the second (b); this is best done, perhaps, on the side where (b) forms a loop (Fig. 343). Then, on the opposite side, the two free ends of the second thread (b) are firmly tied. The ends of the third thread (c) are then tied on the inner side of the pedicle. The threads will then lie as in Fig. 344, firmly interlocked and holding the pedicle tightly. Should a third transfixion be required, the third thread, instead of being tied, must be threaded on the needle in company with a fourth, and the process just described repeated, care being taken to interlock the threads as before. If this precaution be not taken, the unlocked threads pulling in different directions will tend to tear the pedicle apart at the point of transfixion, and vessels may easily escape being commanded. As each of the above loops is tied, the ends of the thread must be cut short, or needless confusion will be entailed.

FIG. 344.

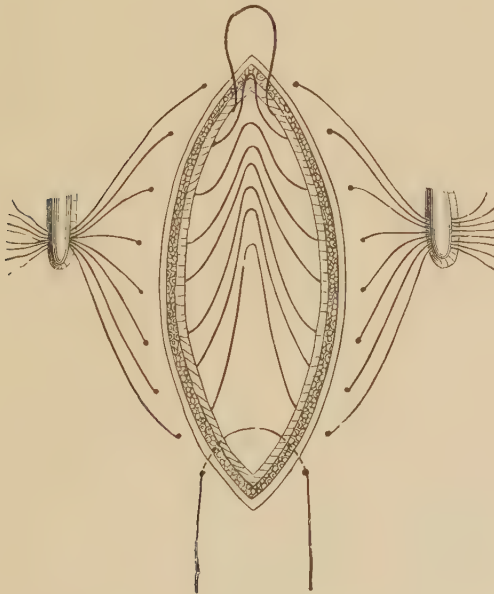


The Toilet of the Peritonæum.—The operator now scrutinises the parts, removes any jagged omentum or bands of adhesions, arrests any still bleeding points, takes out any sponges which he may have inserted, and has them all counted. The next step is to sponge out thoroughly the pelvis, the spaces in front of and behind the uterus, and those on either side of the vertebral column. This is effected by introducing again and again aseptic sponges or sterilised gauze swabs on sponge forceps until they return dry and colourless. In the great majority of cases this will be sufficient, and many operators employ

practically no other procedure. If, however, a cyst has burst during the handling of the tumour, as sometimes happens when the wall is thin or necrotic, and viscid contents or, perhaps, papillary growths have escaped into the peritonæal cavity, it is difficult without undue manipulation of the viscera to get the abdominal cavity clean. Under these circumstances it is preferable to wash out with warm sterilised water, or sterilised water to which '6 per cent. of common salt has been added. This is especially indicated where growth has escaped into the peritonæal cavity from a papillary cyst, on account of the possibility of reinfection from a portion of growth left behind.

Suture of Abdominal Wound.—The abdominal wound may be closed either by using one row of sutures which pass through skin, muscle,

FIG. 345.



(Doran.)

and peritonæum, or by securing the different layers separately. One row only of sutures should be used in cases in which drainage is employed, or in which the contents, though freely removed, were septic, or, again, in cases in which a second operation appeared probable. The introduction of a single layer is effected as follows: A flat sponge being introduced to catch any blood, the abdominal wound is closed by means of sutures of stout silkworm gut. These should be carried through peritonæum, muscle, and skin, care being taken that the stitches pass through the peritonæum within a quarter of an inch of its edge, so that this structure is not tucked in between the surfaces of the wound. Not only should a good bunch of muscle be included, but also the fibrous sheath overlying it. The sutures should pass through the skin about a third of an inch from the edge of the wound, and they should be inserted about half an inch

from each other. When all the sutures have been introduced they are collected near their ends on either side with pressure forceps (Fig. 345). The operator then parts the sutures, hooking them up and down so as to obtain free access to the abdominal cavity without any risk of pulling out a suture. The flat sponge is now withdrawn and the sutures tied, care being taken that neither omentum nor intestines become caught in the loop. Superficial sutures of fine silk or horse-hair should be employed to accurately coapt the edges of the skin.

If the layers of the abdominal wall are to be sewn up separately, the first procedure is to shut off the peritonæal cavity by bringing the edges of the peritonæum together with a continuous suture of fine silk, or preferably catgut. The recti are then approximated either by a continuous or by interrupted sutures of the same material, care being taken to bring together the edges of the fibrous layer overlying the muscle. The edges of the skin are finally sewn together in the same way. The modifications of these two methods made use of by different surgeons are numerous. Dr. Galabin employs interrupted sutures of stout silkworm gut passed through all the layers. Before these are tied he approximates the edges of the fascia superficial to the recti with a continuous suture of gossamer fishing gut. The skin edges are finally united by a continuous horsehair suture. I prefer to unite first of all the edges of the peritonæum with a continuous fine catgut suture. Interrupted silkworm gut sutures are then passed through skin, fascia, and muscle, and before these are tied the rectal fascia is approximated with a catgut suture, the edges of the skin being brought into careful apposition with a continuous horsehair suture after the interrupted silkworm gut sutures have been tied.

Drainage.—Different operators vary much in their practice as regards drainage, and it is difficult to lay down any hard-and-fast rules as to when to employ it. Undoubtedly the tendency is to employ it less and less. Experiments carried out within the last few years on the absorptive powers of the peritonæum have taught us that this structure, when in a normal condition, is capable of absorbing large quantities of fluid and also of disposing of a considerable number of pyogenic organisms introduced into the abdominal cavity. We have to bear in mind, however, that a peritonæum thickened by inflammation, such as we find in some cases of ovarian tumour, has its functions impaired, and is not in a condition to dispose of large quantities of fluid or many organisms. Consequently fluid collecting in the abdominal cavity provides a ready medium for the growth of any organisms accidentally introduced.

Dr. Jellett (*Pract. of Gynæcol.*, 1900, p. 287) puts this question of drainage very clearly. "It must be regarded," he says, "as a line of treatment whose general effect is by no means beneficial, but which may have to be used at times in order to guard against a greater danger." The risks of drainage should be clearly recognised. One serious result is the weakening of the abdominal scar that attends its use, with the subsequent formation of a hernia. The drain may be a cause of re-infection of the abdominal cavity, and when a hard glass tube is employed, may, by pressure on the bowel, lead to the formation of a fæcal fistula. There is one condition in which drainage is certainly called for, and that is when any septic material, as from a suppurating cyst or a

pyo-salpinx, has entered the peritonæal cavity, or when any septic focus has been imperfectly removed.

Drainage is less often made use of after the separation of extensive adhesions. In such cases the surgeon must use his own judgment. He should bear in mind the fact that the absorptive powers of the peritonæum in such cases are impaired, and if he thinks that more exudation is poured out than the peritonæum can deal with, he must employ some form of drainage. For this purpose a glass tube (Keith's) is commonly made use of. One end rests at the bottom of Douglas's pouch without pressing on the rectum; the other passes through a thin sheet of india-rubber, its neck being firmly gripped by a hole in this. One or two sutures should be passed in the usual way through the abdominal wound, above and below the tube, but left untied until the tube is removed. A sponge is placed on the end of the tube to absorb discharges, and the india-rubber sheeting wrapped round it to prevent soiling of the dressings. The sponge should be changed at first every hour, and this is done without disturbing the dressings over the wound; later on the change should be effected every two or three or more hours. At the same time as the sponge is changed the fluid should be sucked out of the drainage tube by means of a glass syringe with a piece of india-rubber tubing attached. The syringe and tubing should be boiled before being used, and the most scrupulous precautions taken against the introduction of organisms from without. It is difficult to lay down rules with regard to the length of time drainage should be employed. When used on account of oozing from extensive raw surfaces one to two days will usually suffice. If employed for a septic case drainage may be dispensed with as soon as a bacteriological examination shows the discharge to be sterile. When, on account of persistence of purulent discharge, drainage is required for some time, the glass tube should be replaced in a few days' time by a rubber one. Mr. Herman recommends that it should be so replaced at the end of twenty-four hours in all cases where longer drainage is required. Owing to the fact that a hard tube is likely to produce a fæcal fistula by pressure on the bowel, and owing to the danger of reinfection that attends its use, many surgeons have discarded it, and now employ gauze instead. Either sterilised or iodoform gauze may be used. It should be cut into strips and its edges turned in and sewn together to prevent the possibility of shreds being detached and left behind in the wound. As it soon ceases to act as a drain, it should be removed twenty-four to forty-eight hours later, fresh strips being replaced if necessary. For drainage through the abdominal wound gauze is not altogether satisfactory. It soon fails to act, necessitating renewal; and I agree with Dr. Galabin that it appears to set up more adhesions than a glass tube. The advantages in certain cases of drainage through the vagina are pointed out by Dr. Jellet (*loc. supra cit.*), and he considers that with a healthy vagina drainage through the bottom of Douglas's pouch is the correct treatment in the majority of cases. It does not weaken the abdominal wound, and drainage is carried out from the most dependent point of the abdominal cavity. The vagina is opened through the pouch of Douglas on the separated points of a pair of forceps pushed up by an assistant into the posterior fornix of the vagina. A strip of iodoform gauze should be passed through the opening from Douglas's pouch into the vagina, about

half an inch of the gauze being left projecting into the peritonæal cavity. The remainder of this strip is left packed in the vagina, and should be removed in two or three days' time.

Encapsuled Ovarian Cysts.—*Cysts of the Broad Ligament.*—*Intra-ligamentous Cysts.*—Cases are occasionally met with in which the cyst growing between the layers of the broad ligament is imperfectly encapsuled and has no pedicle that can be ligatured. In these cases an attempt should be made to enucleate the tumour after making an incision through the peritonæal covering. Mr. Thornton (*Dict. Surgery*, vol. ii. p. 155) has pointed out the advisability of isolating at an early stage the vessels and ligaturing them. Dr. Kelly (*Oper. Gynecol.*, 1898, vol. ii. p. 303), who also draws attention to the importance of securing the vessels early in the operation, points out that the blood-supply is derived from the ovarian and the terminal branches of the uterine vessels, and that these should be sought for, the former on the side of the pelvic brim, the latter on the uterine side of the cyst, after division of the peritonæum. If these are tied at once there need be but little hæmorrhage throughout the operation. The main blood-supply having been secured in this way, the tumour should be enucleated by separating with the fingers the loose connective tissue that holds it in position. The removal of the cyst will be facilitated by emptying it of its contents with a trocar in the usual way. Any bleeding points in the capsule should be seized with pressure forceps and secured. "In performing these enucleations the operator must always bear in mind the fact that he is constantly brought into dangerously close relations with bladder and ureters, rectum and sigmoid flexure, or cæcum and appendix. The large iliac vessels are also occasionally incorporated with the capsule" (Mr. Thornton, *loc. supra cit.*).

After the removal of the cyst the capsule requires attention. If it is very redundant it may be gathered up into a loose fold, transfixed and tied, like an ordinary pedicle (Mr. Bland Sutton, *Surg. Dis. of Ovaries*, 1896, p. 372). If the cavity is small, and there is no oozing, the cut edges of the peritonæum should be drawn together by a continuous silk ligature. If, however, there is much oozing, the edges of the capsule should be secured to the lower part of the abdominal wound, and its interior packed with gauze strips. Sometimes it is found that the cyst is so firmly attached to important structures that its removal becomes an impossibility. The edges of the cyst and the capsule must then be attached to the abdominal wound, and the cavity drained. Such a procedure is not entirely satisfactory, as the cyst is likely to refill later. When intra-ligamentary growths occur on both sides, Dr. Kelly considers that it is easier and better to remove uterus and tumours together, the method adopted being practically the same as that employed by him for hysterectomy.

Incomplete Ovariectomy.—The surgeon may be compelled, very early in the case, to abandon his operation. This will be rendered necessary by the following conditions:—(1) When the tumour is malignant and has infiltrated tissues which cannot be safely removed, or when secondary nodules are found in the abdominal cavity. (2) When the peritonæum is found covered with papillary growths, the result of infection from a papillary cyst. Dr. H. A. Kelly (*loc. supra cit.*, vol. ii.

p. 294) advises removal of the mother-tumour whenever it is possible, as he considers it not only relieves the pressure of the ascites, but checks the rapidity of the growth. Moreover, cases have been recorded by Mr. K. Thornton and others where a disappearance of the secondary papillary growths and a freedom from recurrence have resulted from this line of treatment. (3) When the base of the cyst, whether intra-ligamentary or not, is irremovable, deep in the pelvis, and adherent to the ureters, large vessels, or adjacent viscera. The surgeon must then empty the cyst of its contents, and suture its cut edge to the abdominal incision, all superfluous portions of the cyst being cut away. Before doing this he must check all hæmorrhage, inspect any possibly damaged viscera, and carefully cleanse the back of the tumour and the parts behind it. The remains of the cyst, after being carefully sutured to the lower part of the abdominal incision so as to entirely shut off the peritonæal cavity, should be packed with iodoform gauze. When the cyst contains solid growth an attempt should be made to remove this from the portion of cyst wall left behind, to minimise as far as possible the risk of sepsis and rapid recurrence.

Accidents during Ovariectomy.

(1) *Syncope*.—This appears to be brought about in some cases by too rapid emptying of large cysts. The pressure on the abdominal vessels is relaxed, and they become filled with blood at the expense of the rest of the body. This accident should be avoided by slowly drawing off the contents of large cysts. When it occurs it should be treated by lowering the head, keeping the patient warm, and administering brandy subcutaneously.

(2) *Vomiting*.—This chiefly harasses by straining the intestines out of the abdomen. If prolonged, the operation must be completed as soon as possible, an assistant keeping the viscera in place with a flat sponge or gauze pad.

(3) *Separation of the Parietal Peritonæum*.—It has already been pointed out that this is due to the operator mistaking the sub-peritonæal fat for omentum. It is an accident that may be avoided by care.

(4) *Rupture of the Cyst*.—This accident may be expected when the walls are thin, necrotic, or softened by recent inflammation. In such cases the cyst should be carefully handled, suspicious spots being kept well out of the wound or packed around with sponges. If rupture occurs, the abdomen should be well irrigated with warm boiled water, and if the contents of the cyst are suppurating, drained subsequently.

(5) *Injuries to Viscera*.—Of these the bladder, small intestines, rectum, and ureter are most likely to suffer. The bladder may be injured during the abdominal incision owing to its being drawn up. This, however, is not so likely to happen as in operations for fibroids. Or it may be opened in the course of removal of the tumour. Treatment consists in immediate suture of the organ, and subsequent drainage by catheter to prevent distension. The intestine is most likely to be injured in the separation of adhesions. When possible the wound in the bowel should be at once sutured. If the damage is more extensive the question of resection of a portion of gut will arise. The rectum is sometimes torn in the separation of firm adhesions in the pelvis. The

operator should attempt to sew up the rent, a proceeding that will be much facilitated by the raised pelvis position and a good light. Often suturing will be found to be impossible, and in such case the neighbourhood of the injury should be well packed with iodoform gauze, the ends of which are left out of the abdominal wound, or through an opening in the vaginal vault. Sloughing of the bowel sometimes occurs after the operation, leading to the formation of a fæcal fistula. This is owing in some cases to injury of the intestine during the operation, in others to the pressure of the glass tube used for drainage. For the treatment of cases in which the ureter is injured the chapter on that subject should be consulted (p. 149).

(6) *Severe Hæmorrhage*.—It has already been mentioned that severe or fatal hæmorrhage from injury to large pelvic vessels is rare. Very severe and even alarming hæmorrhage may, however, take place from the cyst wall or its interior. This is especially likely to happen when the solid contents of a papillary cyst are being scooped out by the hand. If the pedicle can be got at readily and ligatured, this should be done quickly. If not, the advice given by Dr. H. A. Kelly (*loc. supra cit.*, p. 296) should be followed: "The only safe plan is to control at once the main vessels going to the tumour by applying artery forceps to the broad ligament at the pelvic brim so as to catch the ovarian vessels, and one or two pairs at the uterine corner to catch the uterine vessels."

(7) *Leaving in Instruments*.—*E.g.*, sponge or forceps. The fact that this accident has occurred with operators of the largest experience should make all careful. It is best met by having a sufficient definite number to begin with, counting carefully afterwards, and allowing no tearing of sponges.

After-treatment.—The patient should be kept on her back for two days after the operation, and a pillow placed under her knees. At the end of that time she may be turned first on to one side, then on to the other. If a glass drainage-tube is made use of, she must be kept on her back till the tube is removed. The most careful attention should be paid to the bedding under her, and the nurse should see that there are no creases in the mackintosh or sheets. A few wrinkles will cause the patient the most acute discomfort.

The retching and vomiting that patients suffer from after an abdominal operation is considerably more than the anæsthetic alone will account for. Drugs should not be employed to combat the sickness. In fact, they will generally be found to be useless. The proper treatment of the stomach is rest during the first twenty hours. The only thing that should be given during this time is hot water, and of this a tablespoonful may be taken at a time as hot as can be borne comfortably. This will be found to be most acceptable to the patient, reviving her, and often removing the feeling of faintness. Ice should not be given either for the sickness or to allay thirst. The iced water remains unabsorbed in the stomach, and is sooner or later rejected. At the end of twenty-four hours small quantities of nourishment may usually be given. It is difficult to lay down rules with regard to quantities. In a straightforward case two drachms of milk, which has been peptonised beforehand, may be given every half-hour to commence with, and the quantity gradually increased. Albumen water,

made by dissolving the white of an egg in half a pint of water, may be usefully given, mixed in equal quantities with the milk. If vomiting is persistent, enough water should be given to keep the mouth moist, and the patient fed with nutrient enemata and suppositories, given alternately every four hours. In slighter cases of vomiting albumen water alone is often well tolerated.

The bowels should be opened about the third day. This is best effected by means of an oil enema given on the morning of the third day, followed later by a soap and water one, or else two or three grains of calomel may be administered on the evening of the second day, followed by a saline purge the next morning. The unloading of the bowels will, as a rule, make the patient more comfortable, relieve flatulence from which she may have been suffering, and allow her to take more nourishment. The patient should be allowed and encouraged to pass her water naturally after the operation. If she cannot do so a catheter should be passed at the end of twelve hours, every possible precaution being taken to prevent infection of the bladder.

The routine use of opium in any form is to be avoided. On this subject I cannot do better than quote the late Mr. Greig Smith's words: "All medicines are, if possible, to be avoided, particularly opium. Pain I believe to be not so strong an indication for opium as restlessness. Sickness and tympanites are predisposed to, if not often caused by, opium. One expects, after the first dose has been administered, to see the patient wake up in the morning with a dry tongue, increased thirst, and some feeling of nausea, which during the day do not pass off, but culminate in restlessness at night, requiring the administration of a second dose. We rarely see a case treated throughout with a perfectly flat or retracted abdomen if opium has been administered. When the patient tosses about in bed, fidgety and restless, without any particular symptoms beyond those incident to a serious operation, opium is undoubtedly of great value" (*Abdom. Surg.*, 1896, vol. i. p. 210).

REMOVAL OF THE UTERINE APPENDAGES.*

Indications.†—Before giving these, I would state that there is no operation in which it is more necessary to consider each case on its

* This term has been used here for convenience' sake, as more comprehensive than "oophorectomy," &c.

† A paper read some years ago at one of our medical societies, and the discussion thereon, has brought this matter prominently before the profession. I would strongly advise my younger readers to study carefully a very weighty letter in the journals of February 7, 1891, bearing the well-known signatures of Sir John Williams and Dr. Champneys. Every sentence will well repay perusal. I quote a few: "Perimetritis is probably the very commonest of all the serious diseases of women. It is also perfectly certain that the great majority of cases get quite well without any operation. We are far from denying that exceptional cases call for surgical procedures, or that cases of prolonged suppuration in the pelvis are properly treated by the application to them of ordinary surgical principles. But this wholesale resort to a mutilating operation, advocated by several speakers at these discussions, calls for serious consideration by the profession. . . . A plea for patience is to be found in the declaration of the operators that the full benefits of the operation are not felt for months or years after. If the operator would exercise this patience before the operation, there might be less need for its exercise by the patient after the operation."

own bearings, to explain the object and results with honourable carefulness to the friends and, whenever possible, to the patient herself, and to remember that this is above all one of those operations which should never be entertained if there are any honest doubts as to the patient's health being really impaired beyond the aid of other treatment, and the impossibility of otherwise restoring her to usefulness in the position of life in which she has been placed; and that it is an operation which may concern the happiness of another besides that of the patient. Due weight must be given to the large part played by neuroses in this matter, and to the fact that till we have carefully published cases in which the results have been submitted to the only true test, that of time, we shall not be in a position to decide how far the after-condition of a great number of the patients who have been submitted to this operation is one of improvement. Finally, it is always to be remembered that it is an operation which has been greatly misused.

The following is a limited list of indications for removal of the uterine appendages:

(1) **Diseases of the Fallopian Tubes and Ovaries.**—Of these the inflammatory affections concern us chiefly, in the form of salpingitis, pyo-, hydro-, or hæmato-salpinx, ovaritis, ovarian abscess, or tubo-ovarian abscess. Other diseases include ovarian new growths which have been considered under the heading of ovariectomy and tumours of the Fallopian tube, which do not call for separate treatment. It is not easy to make rules for guidance that will apply to all cases of inflammation of the appendages. Every case demands careful consideration on its own merits. The broad lines of treatment may, nevertheless, be indicated; they are not unlike those that guide us in the treatment of appendicitis. In the following indications, Mr. Cullingworth (*Syst. of Gyn.*, Allbutt and Playfair, 1896, p. 514) is closely followed:

(a) *Operation during Acute Attack.*—It is not often that surgical interference is called for during an acute attack. The difficulty, and more especially the danger, of the operation is increased during this stage. Moreover, the advisability of treating the inflammation, when acute, by rest is shown by the generally good results obtained. Even if pus is suspected, the surgeon should not be in too great a hurry to operate. One well-defined indication for interference during the acute attack has been laid stress on by Mr. Cullingworth, and that is the accumulation of fluid, more especially if it be purulent, in sufficient amount to distend Douglas's pouch and encroach on the vagina and rectum. Here "there can be no hesitation as to the propriety of making an opening through the vaginal roof. Such timely interference will not only afford immediate relief to the more urgent symptoms, but will prevent the bursting of an abscess into the rectum."

(b) *Recurrent Attacks.*—A history of recurrent attacks of peritonitis almost invariably means the presence of pus. If, with this history, the patient has a swelling which has "attained such dimensions as to make it fairly certain that in the midst of it there is either an occluded and distended Fallopian tube, or an ovary enlarged by cystic growth, the indications for the removal of the disease are perfectly clear."

(c) *The class of life to which the patient belongs must be considered.*

A woman who has to earn her living cannot afford to submit to prolonged treatment by rest, if by operation she can secure a more rapid recovery.

(d) *Persistence of Symptoms after Acute Attack*.—In most cases, with rest and appropriate treatment, the inflammatory mass subsides, the pain disappears, and the patient is restored to health. It occasionally happens, however, that the symptoms persist, and unless some relief is afforded the patient, there is danger that she will drift into a condition of chronic invalidism, and become unfit for any of the ordinary vocations of life. These cases present many points of difficulty, and the treatment to be adopted must depend upon the existing condition. Should it be found that the inflammatory mass, instead of subsiding, persists, the advisability of operating will have to be considered. But before resorting to an operation that involves removal of tubes and ovaries the question of how long expectant treatment should be persevered in presents itself. The class of life of the patient, as a factor to be taken into consideration, has already been mentioned. Mr. Herman, in answering this question, gives the following practical advice:—

“Most cases will get well within two months; but I have seen expectant treatment followed out for two months without relief, and then the patient has begun to improve. I therefore think that three months is the minimum which in doubtful cases should be considered a fair trial of expectant treatment. This is only a statement as to most cases, not a rule to be applied to every case” (*Diseases of Women*, p. 240). On the other hand, the inflammatory mass may have subsided as the result of treatment, but pain persists, and we find on examination that the pelvic organs are displaced and fixed by adhesions. Under these circumstances greater patience must be exercised, and the necessity for removal of the appendages most carefully considered before such a method of treatment is adopted. In some of these cases a conservative operation may be advantageously practised, and proceedings limited to thorough freeing of adhesions and fixation of the organs in better position. And, lastly, we meet with cases in which the pain does not appear to have sufficient physical basis to justify us in recommending any operation.

(2) *Fibro-myoma of the Uterus*.—Oophorectomy no longer occupies the position it did in the treatment of fibroids; its place has been taken by hysterectomy, and there are several reasons for this. The removal of the ovaries is not followed by uniformly satisfactory results, though, as Mr. Doran points out, we can never feel sure, in cases of failure, that all the ovarian tissue has been removed. As, however, some fibroids may go on growing and may require hysterectomy after the menopause, it is only natural to suppose that a similar result may follow the induction of an artificial menopause. Another disadvantage of oophorectomy is that the patient is left with a tumour which, diminishing in size slowly, may have time to exercise injurious pressure on neighbouring organs. It seems reasonable, moreover, to suppose that a patient with both her ovaries, and without a uterus, is in a better position than one possessing a uterus enlarged by fibroids and no ovaries; and such evidence as we possess at present points to the justice of this conclusion.

Removal of the ovaries is by no means an easy operation in all cases. When the tumour is large the operator will find it often difficult, and occasionally impossible, to remove the ovaries, more especially when the tumour grows into the broad ligament.

There are three conditions which, considered separately or together, may influence us in the choice of oophorectomy rather than hysterectomy. The most important is the general condition of the patient. If this is such as to militate against a prolonged operation, oophorectomy should be chosen, provided that the ovaries can be readily got at and completely removed. When, from the nature and situation of the tumour, it is thought that the risks of removal are unusually great, removal of the ovaries may be chosen in preference to that of the uterus. There would be less hesitation in removing the ovaries if the patient were near the menopause, though it should be remembered that this is often delayed till after fifty years of age. Age alone does not often determine the choice of operation, but, taken in conjunction with the condition of the patient or the character of the tumour, it is a factor to be borne in mind. In those cases in which the tumour gives trouble after the menopause, and an operation is called for, removal of the ovaries would, naturally, not be chosen.

(3) **Dysmenorrhœa and various Neuroses.**—Oophorectomy for dysmenorrhœa has been attended by such disappointing results that the greatest hesitation should be adopted in suggesting its performance or carrying it out. Practically the only cases in which removal of the ovaries for severe menstrual pain should be entertained are those in which the pain may reasonably be ascribed to some lesion affecting these organs. In some of these cases the ovaries are the seat of chronic ovaritis, occasionally accompanied by definite inflammation of the tubes. When with such a condition the patient has intolerable monthly pain, which has resisted all attempts at treatment by rest and drugs, and when, as Dr. Griffiths points out (*Syst. Gyn.*, Allbutt and Playfair, p. 864), the suffering is not out of all proportion to the ascertained lesions, removal of the inflamed ovaries will have to be considered. Whilst this operation may relieve the local symptoms, the general nervous symptoms from which these patients suffer very often persist, or become intensified and may prove as grave a source of trouble as the original pain. A very necessary note of warning has been sounded by Mr. Bland Sutton, Dr. Howard Kelly, and others, with regard to the diagnosis of oophoritis. The ovary may normally contain large Graafian follicles, and the presence of these does not constitute oophoritis. A cystic ovary, the result of inflammation, is considerably larger than normal, with a thickened tunica albuginea, and a stroma that is more fibrous and denser than normal. With regard to other neuroses, such as hysteria, epilepsy, and insanity, experience has shown us that the removal of the ovaries for these conditions is not justified by the results obtained. On this subject Mr. Bland Sutton's remarks are worth careful attention: "The removal of the ovaries and tubes has been recommended and practised for the relief of such conditions as (1) epilepsy and insanity; (2) dysmenorrhœa; (3) ovarian neuralgia. In this group the procedure has not been followed by encouraging results; indeed, they are so unsatisfactory, that those who have had the greatest experience

in this class of surgery are almost unanimous in condemning the operation, save under very exceptional conditions: even then the operator should safeguard himself by seeking confirmatory opinion. The chief objections are summarised in the following clauses: (1) In a very large proportion of cases the removal of the ovaries and tubes fails to relieve the patient. (2) In many cases the operation aggravates the symptoms. (3) Many cases, reported a few weeks or months after the operation, have subsequently relapsed. . . . In many instances where oophorectomy has been carried out for relief of pain, unaccompanied by objective signs in the pelvic viscera, the operators have pointed out, in justification of the interference, that the ovaries were cystic. . . . Such men, . . . when they excise an ovary for pain, cut into the organ, and, finding ripe follicles, describe it as a cystic ovary. Every normal ovary is cystic; hence an excuse is readily found." Even when some definite lesion exists the results have not proved satisfactory. Writing of epilepsy, Dr. Weir Mitchell (quoted by Dr. H. Kelly, *loc. cit.*, vol. ii. p. 194) says: "In no case seen by me had ablation of the ovaries and termination of menstruation cured epilepsy. I have never sanctioned such operations where the appendages were sound. I have agreed thrice to these operations in epilepsy with such pelvic disease as of itself would justify oophorectomy. In all three, after some delay, the fits returned, and were in no way permanently aided."

(4) **Osteomalacia.**—The removal of the ovaries in the treatment of this disease has been performed a number of times since it was suggested by Professor Fehling, of Bâle, in 1887, and appears to have met with signal success, the course of the disease being arrested and the patients restored to active life (Bland Sutton, *loc. supra cit.*, p. 384).

(5) **Inoperable Cancer of the Breast.**—The question of oophorectomy for this condition has already been considered in Vol. I. p. 683.

The Operation.

(1) **When Appendages are not Inflamed or Adherent.**—The preparation of the patient, operating-room, &c., is similar to that already described for ovariectomy. An incision of about three inches is made in the median line, and carried down to within an inch of the pubes. The different structures of the abdominal wall are divided until the peritonæum is reached. This is then picked up by a pair of forceps, and, care being taken that intestine is not included in the grasp of the forceps, is divided horizontally. The peritonæum is then incised for the length of the incision on two fingers used as a director. Two fingers are now inserted into the abdominal cavity, and seek the fundus uteri. From this starting-point they are passed along one or other broad ligament, and seize the corresponding Fallopian tube and ovary, which are then drawn out of the wound. With a blunt pedicle needle a double ligature is passed through the broad ligament, and the loop of the ligature being divided, the two strands are interlocked. One ligature is carried round the tube close to its uterine attachment and tied firmly, and the other one is tied over the free edge of the broad ligament. Whilst the ligatures are being tightened the traction on the appendages should be relaxed. A pair of Spencer Wells's forceps are then applied just beyond the ligature, and the ovary and tube cut away. The application of the forceps enables the operator to

carefully inspect the stump for hæmorrhage before allowing it to fall back into the abdominal cavity. The other side having been treated in a similar way, the abdominal wound is sutured. It is not necessary to wash out the peritonæal cavity or to drain.

It has been objected to this mode of tying the broad ligament that it puts tension on it, and drags together its pelvic and uterine ends, so leading to the risk of the ligature slipping, with consequent hæmorrhage. Dr. H. Kelly (*Oper. Gyn.*, vol. ii. p. 198) therefore recommends that the uterine and ovarian vessels should be tied separately. "The first ligature includes the ovarian veins and artery, and is passed through the clear space in the broad ligament and tied near the pelvic brim over the top of the infundibulo-pelvic ligament, well beyond the fimbriated end of the tube. A second ligature is applied to the utero-ovarian ligament posteriorly. A third ligature is passed over the top of the broad ligament at the cornu uteri, embracing the uterine vessels which are visible and the isthmus of the tube." Any bleeding points in the cut edge of the broad ligament are seized with forceps and tied. A longer incision will be required when oophorectomy is performed for fibroids. There may be considerable difficulty in removing the appendages, and in those cases in which the fibroid grows into the broad ligament, spreading out the mesovarium, it may be impossible to apply a ligature between the ovary and tumour.

(2) **Removal of Appendages when they are Inflamed and Adherent.**—This is an operation that may present very grave difficulties in its carrying out. There are two routes by which the removal of the appendages may be effected: the abdominal and the vaginal. Of these the former, besides being the older, is the preferable form of operation. The latter is only suitable to those cases in which the adhesions are not dense and in which extensive fixation to the abdominal viscera does not occur. And as it is extremely difficult to estimate beforehand the character and the extent of the adhesions, the operator had better confine himself to the abdominal route rather than run the risk of having to open the abdomen to complete an operation that was found impracticable from the vagina.

In dealing with the adhesions the late Mr. Lawson Tait considered it best to depend entirely upon the sense of touch; and he has been followed in this teaching by many surgeons. The operation is carried out through a comparatively small abdominal incision, and the sense of touch is relied on entirely in guarding the operator from the infliction of injury whilst separating the tubes from adherent structures. The operation will, however, be much facilitated for those with less experience by bringing into play not only the sense of touch, but that of sight. For this purpose the patient should be placed in the Trendelenburg position as affording a better view of the pelvic viscera.

Abdominal Incision.—The patient being in this position, an incision about four inches long is made in the median line and carried well down to the pubes. The steps of this part of the operation are similar to those described in ovariectomy. On reaching the peritonæum care must be taken in opening the abdominal cavity, and the operator should bear in mind the possibility of adhesions existing between the omentum or intestines and the wall. The peritonæum is picked up and rolled between the finger and thumb, and, the absence of adhesions being

noted, is incised, when the viscera at once fall away from the parietes. Omentum or intestines found adherent to the abdominal wall must be carefully separated by means of the fingers.

Adhesions.—The condition existing should then be carefully ascertained, and the first thing likely to demand attention is adherent omentum. This is frequently found covering in and adherent to the pelvic viscera, and it may also be much thickened by inflammation. It should be freed carefully from its attachments to the pelvic organs with the fingers, care being taken not to injure intestines or bladder. Any bleeding points should be at once secured. If much difficulty exists in freeing the omentum or in determining its exact relationship to other parts, it had better be ligatured and divided, the lower attached portion being dealt with later. In any case it is better to ligature and remove portions of omentum much thickened by inflammatory changes. If intestines are adherent they must be separated with great care, and it is in this stage of the operation that the Trendelenburg posture will be found of great assistance. The bowel, more especially after the separation of firm adhesions, should be carefully inspected, and any damage to the walls at once repaired. All adhesions existing between the intestines and omentum on the one hand, and the pelvic viscera on the other, having been freed, the abdominal organs are pushed back towards the diaphragm and maintained in position with a large flat sponge or gauze pad. There may be some difficulty in doing so if the abdominal walls are rigid and the patient not fully under the anæsthetic. A little patience, however, will, as a rule, allow of the viscera being pushed up out of the way, so as to enable the operator to obtain a view of the pelvic contents.

Enucleation of Appendages.—The operator is now in a position to set about freeing the adherent appendages. As far as is possible the condition present is ascertained by sense of sight as well as that of touch, the position of the uterus located, and the extent and fixity of the mass, formed by one or both appendages, noted. The matted tube and ovary form a tumour lying to the back of the uterus and broad ligament in the lateral fossa or Douglas's pouch, and the broad ligament is drawn over the front of the mass. The first step in enucleation is the separation of the mass from its posterior connections and from the opposite appendages, if inflamed. To effect this, the hand, with the palmar surface forward, is passed down in the hollow of the sacrum behind the mass, carefully separating with the tips of the fingers the adhesions that fix it in this situation. Mr. Cullingworth considers that at this stage it is often desirable for an assistant to pass a forefinger into the rectum to serve as a guide. Working down in this way, the lower part of the mass is reached. The next step is its separation from the back of the broad ligament to which it is fixed, and which effectually prevents the tube being drawn up into the wound. Enucleation is consequently continued from below upwards with the tips of the fingers inserted between the mass and the back of the broad ligament. In this way it is gradually freed from all its connections.

Removal of Diseased Parts.—The affected parts are now drawn well up through the abdominal incision, and a suitable point in the broad ligament chosen for transfixion. A blunt pedicle needle with a double ligature is then passed through the broad ligament, and the loop

divided. The two strands are interlocked where they pass through the broad ligament to prevent the tearing apart of this structure, when they are tied. Each ligature is then tied separately, one round the Fallopian tube close to the uterine cornu, the other round the free upper border of the broad ligament, and, a pair of forceps being applied to the tube just beyond the ligature, the diseased parts are cut away. Where there is likely to be any tension after ligaturing the broad ligament in this way, the method described above of securing the vessels separately had better be employed, as considerable risk exists of the ligatures slipping.

The cut end of the tube held in the forceps is next brought into view and carefully wiped with 1-1,000 perchloride of mercury solution, or else cauterised with Paquelin's cautery to obviate the risk of subsequent infection from the cut end. Before allowing the stump to fall back into the pelvis, the parts are carefully examined for bleeding points, which should be seized with forceps or else under-run. Care should be exercised in the application of forceps in the pelvis lest a portion of the rectal wall be nipped, and its vitality so affected that it subsequently sloughs.

Treatment of Tube when Distended.—If the tube is found to be distended with pus or other fluid, it is better, if possible, to remove it without previously emptying it. This is recommended on account of the greater ease of dealing with a distended tube than one empty and collapsed. Greater care must, however, be exercised in the separation of adhesions, and the parts packed round with gauze or sponges to prevent, as far as possible, the spread of infective material if the tube ruptures, as it may very possibly do in the course of manipulation. Should rupture occur, the fluid must be removed as rapidly as possible, all infected sponges and swabs taken away, and the parts thoroughly cleansed.

Hæmorrhage.—Oozing from large raw surfaces is sometimes free, but generally yields to pressure exercised by sponges in the course of the operation. Should it still persist, and no obvious bleeding point be visible at the end of the operation, the pelvis should be packed firmly with strips of gauze, the ends of which are left out of the lower part of the abdominal incision or carried through an opening in the vaginal vault. The strips should be removed at the end of twenty-four hours. This is preferable to the employment of the cautery or perchloride of iron. Bleeding to such an extent as to be alarming is, when it occurs, most likely to be due to injury to the broad ligament and its vessels in the separation of the tube from its posterior surface. A search may be made for the vessel with the patient's pelvis raised and a good light. This, however, will be found to be most difficult, and will very likely be unsuccessful. The advice given in Dr. Baldy's *Gynæcology* (1894, p. 509) to secure the ovarian and terminal branches of the uterine artery by passing a threaded needle through the broad ligament close to the pelvic wall, and a second one through the broad ligament near the uterine cornu, appears to be worthy of trial under these circumstances.

Drainage will be called for more often in the case of pelvic inflammation than of ovarian tumours. The following may be regarded as indications for its employment:

- (1) When large raw surfaces have been left after the separation of

extensive adhesions, and it is thought that the amount of exudation likely to be poured out is more than the damaged peritonæum can deal with.

(2) When, in the course of removal, a pyo-salpinx, or abscess-cavity, has ruptured and soiled surrounding parts.

(3) When the bowel has been injured in the course of the operation. Damage to the small intestine can generally be repaired without risk of subsequent leakage. Injury to the rectum cannot be so readily dealt with, and it may be impossible for the operator to gain such access to the damaged parts as will enable him to repair the lesion. To prevent general infection of the peritonæal cavity, as the result of leakage from the bowel, he will have to depend on careful gauze packing.

(4) When the operation is incomplete. Firmness of adhesions and danger of injury to viscera will sometimes lead the surgeon to leave his operation unfinished rather than subject his patient to unusual risk. He has probably exposed, in the course of his manipulations, infected areas, such as a pyo-salpinx or a pelvic abscess. Under these circumstances he will remove such diseased structures as is found possible, and provide free drainage by means of gauze strips for the infected parts left behind.

Conservative Surgery.—By this term is meant the preservation of such organs or parts of organs as are not diseased or not beyond the power of recovery. This, which is the general principle underlying all true surgery, receives special significance in its application to the pelvic organs on account of the importance of the latter in securing the happiness and well-being of the individual. This applies more especially to the ovaries, which are not only essential to the functions of menstruation and child-bearing, but which exercise—probably by means of some internal secretion—a wide influence over nutritive processes in general. That every effort should be made to preserve a portion at least of one of these organs is not disputed at the present time; the only question is how far one is justified by one's attempts at conservatism in subjecting the patient to increased risks of recurrence of disease and further operation.

An important step was made in conservative surgery when it was recognised that disease limited to the appendages of one side did not necessarily mean the removal of the organs on both. A further advance was marked by the recognition that certain conditions, which at one time were thought to be pathological, were not diseases at all.

The cystic ovary is a case in point. Though a definite pathological condition does exist in which the ovary is the seat of numerous small cysts, the mere presence of these does not necessarily constitute an abnormal state of the organ, nor do they justify its removal.

A further reason advanced for the practice of conservatism lies in the fact that portions of organs left behind are capable of performing the functions of the entire organ. It has been shown clinically that the stump of an amputated tube may convey an ovum to the uterus, which will then pass through the developmental changes of normal pregnancy (B. F. Baer, *Ann. of Gyn. and Ped.*, January, 1894).

Dr. Kelly (*loc. cit.*, p. 188) has recorded a case in which pregnancy followed an operation involving the removal of one tube and the opposite ovary, and where the transmission of the ovum was effected by the

tube on the side opposite to that of the ovary. Similar cases have been recorded in which pregnancy has followed operations involving partial removal of the appendages. Whilst such an event may not be very common, the mere fact that it can occur constitutes a further reason for exercising such conservatism as is possible in dealing with the pelvic organs.

The capacity for repair shown by inflamed pelvic organs and the powers of absorption of the peritonæal sac in the case of large inflammatory exudates are well-established facts. A similar course of events is known to all surgeons in the case of the vermiform appendix. This power of regeneration is a point telling in two ways, for whilst it will encourage the operator to sacrifice as little as possible of the organs he is dealing with, it is also an argument in favour of rest and expectant treatment.

There are certain conditions other than disease of the tubes and ovaries demanding operation in which there can be no doubt as to the advisability of leaving the ovaries or as much of them as can be safely preserved. Hysterectomy for fibroids is a case in point, where one or both ovaries should be left when possible. A further example is seen in parovarian cysts, which may be shelled out sometimes from the broad ligament without sacrificing tube or ovary.

When we come to disease of the ovary itself, it is especially in non-inflammatory affections that an attempt may be made to save a portion of the organ. Such conditions as cysts due to enlargement of Graafian follicles or corpora lutea may be dealt with on this principle, the cyst being shelled out or a wedge-shaped portion of the ovary being removed. In the case of dermoids and the cystomata the ovarian tissue is, as a rule, so involved that an attempt to save a part of it will not often be found possible. Even when, as occasionally happens, some of the ovarian tissue remains unaffected, the advisability of trying to preserve it is open to question on account of the risk of leaving behind sufficient of the tumour to lead to a recurrence. Nor does it seem improbable that the remaining portion of ovary is liable to a similar cystic change. The chief justification for saving a part of the organ would be in the fact that the opposite ovary either required removal or had already been removed.

It is in dealing with inflammatory conditions of the appendages that the widest difference of opinion with regard to conservatism exists. It was the practice at one time, if the appendages on one side were diseased, to remove those on the other side, even if found healthy. This was done more especially in those cases in which the tubes were the seat of suppuration. The late Mr. Greig Smith (*Syst. of Gyn.*, Allbutt and Playfair, 1896, p. 910) said: "The removal of the appendages on one side only for suppurative disease was tried by Tait, but given up on account of the large number of recurrences or relapses. Other surgeons have had similar experiences; and the rule in all cases of suppurative diseases of the appendages now is that if one set is removed, so also should be the other."

In spite of the risks of recurrence, modern opinion inclines strongly to the preservation of healthy appendages, and, as the interior of the uterus is the source of infection in most cases, the more rational treatment is to attend carefully to this, and thus prevent the extension

of inflammation, so far as is possible, to the sound appendages. Before deciding to leave them they should be carefully examined. Should pus be found to exude from the end of the tube, it should be removed. Such a high authority as Dr. Howard Kelly (*loc. cit.*, vol. ii. p. 186) recommends that under certain circumstances the contents of the tube should be squeezed out and its interior washed out with saline solution, and then sterilised with 1 in 5,000 corrosive sublimate solution. It is difficult to believe that the tube can be effectually sterilised in this way, and its preservation would seem to invite reinfection of the peritonæal cavity. Until more evidence is forthcoming with regard to this procedure it appears unsafe to recommend it for general adoption. On the subject of adhesions Dr. Kelly has laid it down as a rule that these do not in themselves constitute a reason for the removal of organs. The mere presence of adhesions does not imply that the organs are beyond the power of recovery, and, in fact, there is plenty of clinical evidence to the contrary. It has already been mentioned that in some cases the persistence of symptoms is due rather to adhesions binding down the pelvic organs in abnormal positions than to the presence of any source of inflammation. Under these circumstances, operative proceedings may be limited to the separation of adhesions and the fixation of organs in better position. Dr. Kelly has laid stress on the importance of not only freeing the organs from surrounding parts, but also of liberating any kinks in the tube, a condition that may render the patient liable to tubal pregnancy.

Whilst treatment limited to the freeing of organs may be followed in those cases in which the inflammation has subsided, it should not be adopted when they are still inflamed. The separation of adhesions without removal of the cause is certain to be followed by the formation of fresh ones, besides breaking down the barrier that limits the spread of infection.

The question may arise as to whether the Fallopian tube should be preserved when removal of the corresponding ovary is found necessary.

In inflammatory conditions of the appendages, it is uncommon to find a case in which the ovary requires removal and the tube is found in a healthy state. Moreover, the tube is useless without the ovary, and, as the late Mr. Greig Smith has pointed out, the removal of the latter will probably cause kinking of the tube. Consequently, if the ovary is removed, it is usually safer to remove the tube also (*loc. supra cit.*, p. 909). It might be left if operative measures have resulted in the preservation of the opposite ovary, but removal of the corresponding tube. In Dr. Kelly's case, quoted above, pregnancy followed such an operation, leaving one ovary and the opposite tube.

Those conditions have been pointed out in which the practice of conservative surgery may be safely advised. But there are certain operations more open to debate, such as the washing out of tubes containing pus, the amputation or resection of diseased tubes, and the opening of closed tubes. In the hands of the chief advocates of conservatism these procedures have met with results that may be regarded as encouraging, but, with our present information, they are not operations that can be recommended for general adoption.

CHAPTER XVIII.

OPERATIONS ON THE UTERUS.

REMOVAL OF MYOMATOUS UTERUS BY ABDOMINAL SECTION.—CANCER OF THE UTERUS.—REMOVAL OF A CANCEROUS UTERUS BY ABDOMINAL SECTION.—REMOVAL OF A CANCEROUS UTERUS PER VAGINAM.—CÆSARIAN SECTION.—PORRO'S OPERATION.—ECTOPIC GESTATION.

REMOVAL OF MYOMATOUS UTERUS BY ABDOMINAL SECTION.

Indications for Operation.—A fibroid tumour of the uterus does not by its presence merely afford a sufficient indication for operation. It must either give rise to symptoms which threaten life, or be a source of such discomfort from its size or position as to prevent a patient enjoying a reasonably comfortable existence or earning a livelihood. The following is a list of indications that justify removal of a myomatous uterus :—

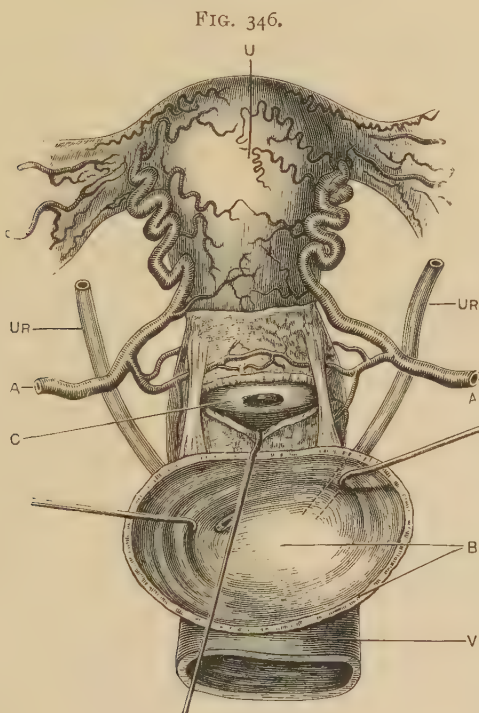
(1) **Hæmorrhage.**—Profuse hæmorrhage at the menstrual periods is the symptom that is the commonest, and that most often necessitates a patient seeking advice. The amount lost, and its effect on the patient's health, the influence of drugs and general treatment, the age of the patient, are all factors to be taken into consideration. The favourable influence that the change of life often has on these tumours should be borne in mind, and if a patient is nearing the menopause it may be advisable to recommend her to wait a year or two. The fact that the climacteric is generally postponed, and not infrequently deferred till after fifty years of age, should be remembered, and if the hæmorrhage is very profuse, leading to profound anæmia, and very little relief is afforded by milder measures of treatment, the advisability of a radical operation should be put before the patient.

(2) **Pressure Symptoms.**—These are most marked in the case of medium-sized tumours impacted in the pelvis. The most common symptom is frequent or difficult micturition. There may also be trouble in keeping the bowels open, owing to pressure on the rectum. The ureters may be pressed on, and hydro-nephrosis or pyelo-nephritis result. These symptoms are most marked just before the onset of the menstrual flow, when the tumour is swollen as a consequence of the natural engorgement of the organs.

Pain in association with fibroids is due not only to pressure on

nerves and neighbouring organs, but also to attacks of peritonitis and inflammation of appendages. Dr. Kelly draws special "attention to the fact that those myomata which are constantly associated with great pain almost invariably belong to the class of complicated cases in which a tubal or ovarian inflammatory disease will also be found" (*loc. cit.*, vol. ii. p. 367).

(3) **Great Size.**—A large tumour in the abdomen may not necessarily threaten life, but may be a source of grave inconvenience and discomfort. It interferes with the return of blood from the lower limbs, and



Relation of the ureters and uterine arteries to the cervix. (Baldy.)

U, Uterus.	C, Cervix.
UR, Ureter.	V, Vagina.
A, Uterine artery.	B, Section of bladder.

so causes oedema; it presses on the stomach and impedes digestion; it limits the movements of the diaphragm, and so interferes with respiration; and, by preventing an active existence, leads to a condition of general ill-health. As Mr. Herman (*loc. supra cit.*, p. 822) points out, "these consequences of great bulk not only call for operative cure; unfortunately they do more: they add to its risk. . . . In the present state of abdominal surgery, the risk to life in the removal even of a big fibroid is small, and the possible undesirable after-consequences are less grave than the constant presence of a great tumour. A well-advised patient will, therefore, welcome relief by operation."

(4) **Rapid Growth of the Tumour.**—If at intervals of a few months

the tumour is found to be markedly increasing in size, the question of its removal will have to be considered. Very rapid enlargement is usually due to secondary changes occurring in it, such as œdema, cystic formation, or hæmorrhage. A sarcomatous change will also be responsible for a rapid growth, but is of rare occurrence.

(5) **Complications**—due to associated inflammatory disease of the appendages and peritonæum, tumours of the ovary, cancer of the uterus—will call for operative interference.

There are three methods employed in the removal of a myomatous uterus, in two of which the hysterectomy is partial, in the third total. They are respectively—

(i.) Supra-vaginal hysterectomy; extra-abdominal method of treatment of stump.

(ii.) Supra-vaginal hysterectomy; intra-abdominal method of treatment of stump.

(iii.) Total hysterectomy.

(i.) **Supra-vaginal Hysterectomy. Extra-abdominal Treatment of Stump.**

Incision.—The patient having been prepared as for ovariectomy, an incision is made in the median line, proportionate to the size of the tumour to be removed. If necessary it is continued upwards to the left of the umbilicus. The incision should be carried well down towards the pubes, as by this means the subsequent steps in the operation are facilitated. Especial care should be taken in dividing the peritonæum, as the bladder is frequently drawn up, and thus rendered liable to injury; moreover, a cut made accidentally into the tumour is likely to lead to very troublesome hæmorrhage, difficult to arrest. To avoid these dangers the peritonæum should be pinched up towards the upper part of the incision and carefully examined before being cut through. The opening is then enlarged upwards and downwards on two fingers used as a director, the height to which the bladder ascends being in this way readily detected.

Delivery of Tumour.—A hand is now introduced into the abdomen and the condition present noted. Any adhesions found must be dealt with. These present much more difficulty than in the case of ovariectomy, partly on account of the size of the tumour, and the fact that it cannot be diminished by tapping, partly on account of the bleeding that follows their separation. Mr. Thornton says on the subject of adhesions: "If they are present, especially if they are omental, they often contain enormous vessels, and in separating them great care is required to avoid serious loss from the uterine side after they are tied and divided on the proximal side." He points out that "adhesions of large surfaces of intestine are exceedingly difficult to deal with; there is no room to apply ligatures before separating, and no room, or not firm enough tissue, to apply pressure forceps after separation; thus both surfaces frequently ooze very freely. . . . Sponge pressure is the only way of dealing with these oozing surfaces" (Allbutt and Playfair, *Syst. of Gyn.*, 1896, p. 615).

In the simplest cases the tumour is seized hold of and brought out of the wound, care being taken not to exercise such traction as will result in tearing of its pedicle, an accident that may cause dangerous bleeding. But it sometimes happens that the delivery of the tumour from the

abdomen presents great difficulty, and it may be found necessary to divide the broad ligament on one or both sides before this can be effected.

Treatment of Ovaries and Bladder.—Before the ligaments are dealt with the operator must decide whether one or both ovaries shall be preserved. The importance of saving one at least has been referred to in the chapter dealing with the appendages. Mr. Thornton, as the result of his wide experience, says: "I always leave an ovary if I can, as I find that, if this be done, the patients recover more quickly and completely, and suffer infinitely less at the change of life; especially do they escape the depression which is apt to follow the complete removal of uterus and ovaries." If it is found that the ovaries are healthy and that their preservation is feasible, the surgeon proceeds to divide the broad ligaments. The method of dealing with these structures is described in the next section, on the intra-peritonæal operation. Whether they have to be ligatured and divided with the tumour in the abdomen, or brought outside it, the details are the same. The next point requiring careful attention is the bladder. The operator must be very careful that this is not included in the rubber or wire ligature. Some surgeons prefer to keep the bladder full, in order to define its limits, but this is not necessary. If any doubt exists as to the height to which this organ extends on the front of the tumour, a sound should be passed. If it ascends over the part to which the constriction is to be applied, it must be reflected from the uterus. To carry this out an incision is made through the peritonæum, from side to side, half an inch above the bladder, and this organ carefully separated by means of the finger from the uterus.

Treatment of Pedicle.—The constriction of the pedicle may be effected either by means of wire or rubber ligature. If the former method is to be made use of, thick, soft iron wire, that will not readily cut through the tissues, should be employed, and the best form of clamp is Koeberlé's *serre-nœud*. The wire, having been adjusted round the neck of the tumour, is slowly tightened up by means of the clamp. Two transfixion pins are then passed through the pedicle immediately above the wire, and the tumour cut away about an inch above the pins. Instead of wire an elastic rubber ligature may be employed. Professor Hegar used an india-rubber cord five millimetres thick, which by means of a special needle was made to transfix the cervix. The two halves were then tied separately, and the whole cervix encircled by another ligature placed below the two preceding ones. The double ligature does not

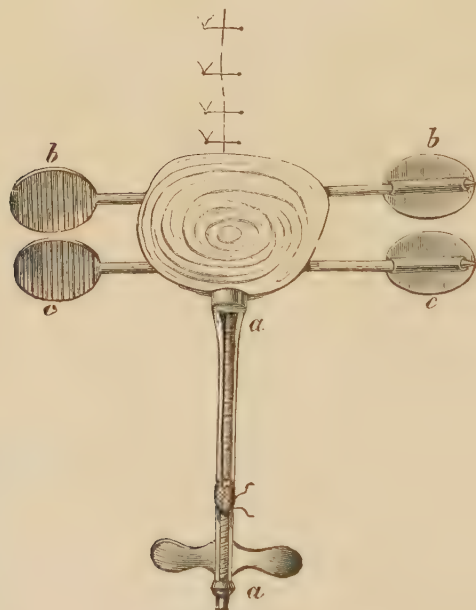
FIG. 347.



Koeberlé's *serre-nœud*.
(Galabin.)

appear to be necessary, and one rubber ligature drawn round the cervix is sufficient, means being taken to prevent it slipping by grasping the knot in a pair of forceps. There will probably be some shrinkage of the stump as the tumour is cut away, necessitating the tightening up of the wire by a few turns of the screw of the clamp. The stump is pared carefully, either now or after closure of the abdominal incision. Mr. Thornton, to whom so many details of the operation in its present form are due, pares down the stump as much as possible, especially cutting away the inside fibrous and muscular tissue into a somewhat cupped shape. It has been recommended that the peritonæum of the pedicle should be drawn over the cut surface of the stump and sutured

FIG. 348.



The lower part of the abdominal wound is shown sutured above the stump. *a, a*, serre-nœud; *b, b*, pin passing nearer the anterior; and *c, c*, pin passing nearer the posterior boundaries of the stump. (Doran.)

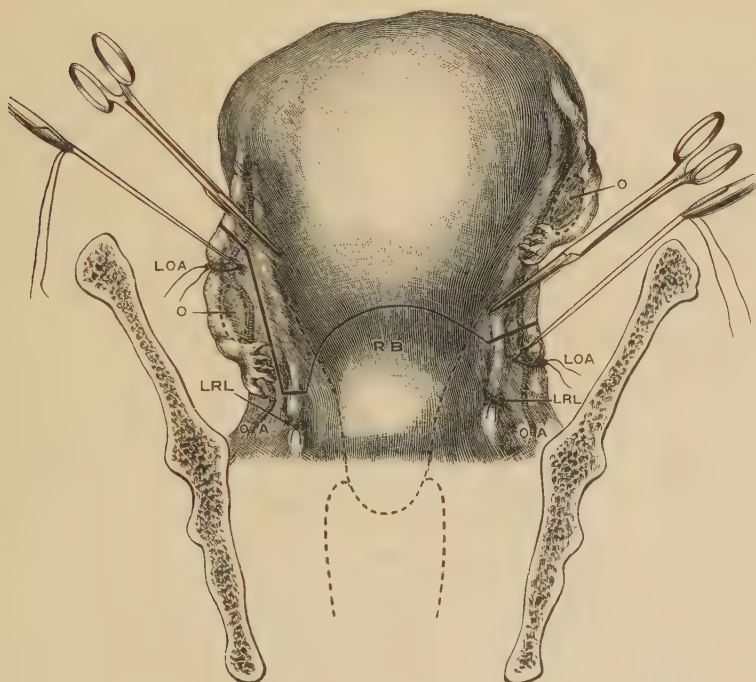
there. This is unnecessary, and, as Mr. Thornton points out, merely serves to enclose materials which are much better escaping into the dressings. The peritonæum of the abdominal wall is now secured to that of the pedicle below the wire by two or three sutures, and the ventral incision closed in the usual way. The stump is powdered with iodoform and dressed with iodoform gauze, care being taken to insert several layers of gauze beneath the pins and the clamp.

After-treatment.—The dressing should, if possible, be left untouched for a few days, one or two turns of the screw being made in the case of large pedicles. The stump is often ready to come away in two or three weeks' time. If it does not then show signs of doing so, it may be clipped down to the wire and pins, and these latter removed altogether.

(ii.) Supra - vaginal Hysterectomy. Intra - abdominal Method.

The mode of operation described is, in its essentials, that associated with the name of Dr. Baer,* of Philadelphia. The principles on which he based his operation were—"first, control of hæmorrhage by ligature of the blood-vessels in the broad ligaments; second, non-constriction of the cervical tissues, so that there shall be no cause of suppuration; and

FIG. 349.



Operation of supra-vaginal hysterectomy seen from the front.
First stage. (Galabin.)

A double ligature is placed on both ovarian arteries, and a single ligature on both round ligaments. The thick black line indicates the line of incision through the broad ligaments; the thin black line, the line of division of the anterior peritonæum; L O A, ligature on ovarian artery; L R L, ligature on round ligament; O, ovary; O A, ovarian artery; R B, reflection of bladder.

third, non-disturbance of the cervical canal, so that sepsis from the vagina may be prevented." Dr. Kelly (*loc. supra cit.*, p. 365) draws attention to the fact that the very important step of systematically securing the ovarian and uterine arteries in their course, as a preliminary to hysterectomy, was devised by Dr. L. A. Stimson, of New York.

The Operation.—The initial stages of the operation are similar to

* This method of operation was published in the *Transactions of the American Gynaecological Society*, vol. xvii. (1892), p. 234, and vol. xviii. p. 62.

those described in the extra-abdominal method. It will be considerably facilitated in some cases by placing the patient in the Trendelenburg position. The incision having been made through the abdominal wall, the condition of the parts examined and adhesions dealt with, the tumour is delivered as previously described. As in the preceding method, it may be found necessary to deal with the broad ligaments before delivering the tumour, and to divide part of them on one or both sides with the uterus still in the abdomen. The steps of this part of the operation are similar to those taken when the tumour can be brought through the ventral incision.

Division of Broad Ligaments.—The uterus having been drawn out of the abdomen, the operator carefully examines the broad ligaments and appendages on each side, and decides whether he will leave one or both ovaries, or whether he will remove them both. When possible, one at least should be saved, exception being made in those cases in which they are found diseased, or when it is found impossible to leave them, or the patient has reached the menopause. The surgeon, after carefully examining both sides, chooses that which can most easily be dealt with, and, seizing the upper part of the broad ligament, passes through it, at a point free from vessels, a blunt pedicle-needle threaded with silk or catgut. The exact point of perforation will depend upon whether the ovary is to be removed or not; in the former case the ligature will be carried round the free edge of the broad ligament; in the latter it will include the Fallopian tube.

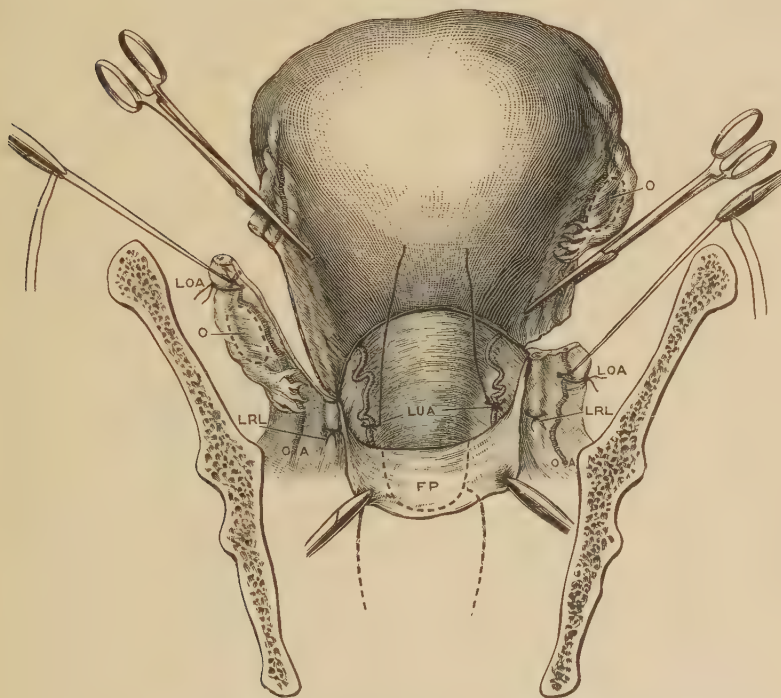
This ligature, which secures the ovarian artery, is then firmly tied, and that portion of the broad ligament next the tumour being secured by means of forceps, the part intervening between the ligature and the forceps is divided (Fig. 349). A second ligature is passed through the broad ligament of the same side, lower down, including the round ligament, and firmly tied; the proximal portion of the broad ligament is clamped, and the part between forceps and ligature divided. In most cases these two ligatures will be found sufficient, but more can be applied in the same way if required. The use of forceps for clamping the proximal part of the ligament, as described above, rather than ligatures, will be found to effect a saving of time. The opposite side is then dealt with in the same way.

Formation of Anterior Flap.—The next step in the operation is the reflection of a flap of peritonæum and the bladder from the front of the uterus. An incision is made through the peritonæum covering the front of the uterus, from side to side, about an inch above the line of attachment of the bladder, the position of which should be carefully ascertained. It should be carried across to join at each extremity the lower end of the cuts in the broad ligaments. The bladder is then separated from the uterus by means of the finger, any firmer bands (and these are met with especially in the median line) being divided with scissors. Care should be taken in this separation, as the bladder is sometimes much thinned by stretching, and it does not require much force to push the finger through into its interior. Should this accident happen, the opening must at once be closed with sutures. A small peritonæal flap may be raised on the posterior surface of the uterus, but this is not necessary, and may quite well be dispensed with. By the reflection of the anterior flap some loose cellular tissue

on each side of the neck of the myomatous uterus is exposed, and in this there may be felt pulsating, and sometimes seen, the uterine artery.

Ligature of Uterine Artery.—The position of the artery is now carefully defined on one side, and a ligature threaded on a pedicle-needle is passed through the cellular tissue between the artery and the uterus. A pair of Spencer Wells's forceps are now applied so as to

FIG. 350.



Operation of supra-vaginal hysterectomy seen from the front.
Second stage. (Galabin.)

The outer part of the broad ligament is divided on each side. The anterior peritonæal flap is stripped down and held by two pressure forceps. One ligature is placed on each uterine artery. A second ligature is passed through the broad ligament just within it, ready for subsequent use. L O A, ligature on ovarian artery; L R L, ligature on round ligament; L U A, ligature on uterine artery; O, ovary; O A, ovarian artery; F P, anterior flap of peritonæum.

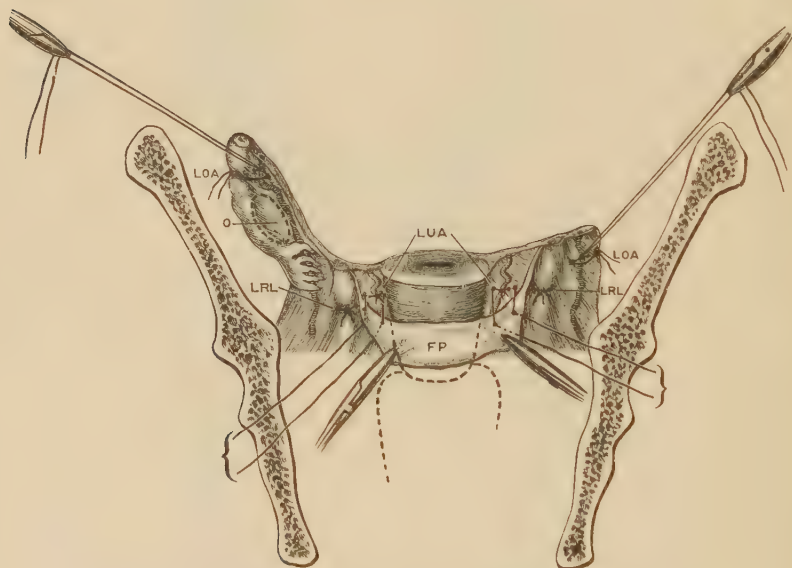
include the artery a little above the ligature, and the latter is firmly tied. The tissues, including the uterine artery, are then divided between the ligature below and the forceps above, and if the ligature has been properly applied there will be no bleeding. If the artery has not been secured it will spurt on division, and should be promptly seized with forceps and tied. The same procedure is adopted on the opposite side.

Removal of Uterus.—A point has now been reached at which the blood-supply has been secured, and nothing is left keeping the enlarged

uterus in position but the narrow neck below. The only remaining step is to divide this latter. The intestines being kept out of the way, the left hand is passed down behind the neck to prevent the possibility of injury to bowel, and the pedicle is divided with knife or scissors just above the point at which the uterine arteries are secured.

The division of the pedicle is effected in various ways. The simplest method is to make an incision straight through, so as to leave a flat raw surface, which is subsequently covered in by the peritonæal flaps. Dr. Baer, in his original description (*loc. supra cit.*), considered that in most cases it was sufficient to allow the flaps to fall

FIG. 351.



Supra-vaginal hysterectomy seen from the front. Third stage.

The uterus has been cut away. The ligature on each side, for stitching the anterior peritonæal flap over the uterine artery, is passed and ready for tying. L O A, ligature on ovarian artery; L R L, ligature on round ligament; L U A, ligature on uterine artery; O, ovary; F P, anterior flap of peritonæum.

together over the stump, and that there was no need to suture them. To render the stump completely extra-peritonæal it is better, however, to accurately coapt the cut edges of the peritonæum. This is effected by means of a continuous catgut suture. The divided edges of the broad ligament on one side are first sewn together. The anterior flap of peritonæum is then drawn over the stump, and its free border sutured to the cut edge of peritonæum at the back of the stump, the operation being completed by sewing together the two edges of the remaining broad ligament. In defining the principles on which this operation was based, Dr. Baer laid stress on the importance of not disturbing the plug of mucus in the cervical canal, as he regarded this as a bar to the spread of infection. Though in healthy women the interior of the uterus appears to be free from organisms, in some cases of fibroids

there is a purulent discharge from the organ, and one objection made to the simple division of the cervix is that infection of the wound may take place from the cervical canal. To prevent this happening, the closure of the canal is recommended by some operators. This may be effected by making the incision through the cervix V-shaped, and approximating closely the two flaps by sutures. Dr. Kelly prefers to so hollow out the stump as to leave it cup-shaped, the canal being closed by sutures, which are passed from before backwards, and which convert the cup into a transverse linear wound. As a further precaution against infection the canal may be excised with knife and scissors or cauterised. Mr. Doran, in opening a discussion on the treatment of fibroids (*Brit. Med. Journ.*, Sept. 15, 1900), did not advocate the closing of the stump by sutures, as he considered this procedure was liable to be followed by sloughing. I have not seen this complication occur as the result of sutures. Cellulitis may occur after either method of treatment of the pedicle, but I have seen less of it since closure of the cervical canal has been adopted. I prefer a V-shaped incision, the edges being brought together by means of stout catgut.

Comparison of the Intra and Extra-abdominal Methods.—At the present time it is scarcely necessary to compare these two methods of treatment of the stump. The latter has been almost entirely replaced by the former operation. We have retained the description of the extra-abdominal treatment of the stump, as it has been found to be useful in cases of emergency. When, however, the operator is possessed of some skill in abdominal surgery, and has adequate assistance, he should undoubtedly leave the stump within the abdominal cavity. The weak points of the extra-peritonæal method are these:—

(1) The prolonged convalescence, lasting for six or eight weeks, while the slough is separating. After the intra-abdominal method the wound quickly heals, and the patient is able to get up in three or four weeks' time. This is generally held, and I think rightly, to be a great advantage; but Mr. Herman does not consider it to be so great as might be thought, as the nervous shock caused by the operation, and consequently the time required to regain the former energy, is the same in both cases.

(2) The granulating area in the abdominal wall leaves a cicatrix which is liable to yield and give rise to a ventral hernia. Though a hernia may arise after careful and close suture of an abdominal wound in its whole length, it is much more common in those cases in which part of the incision is allowed to close by granulations, as when drainage is employed or after the separation of the stump in extra-peritonæal hysterectomy.

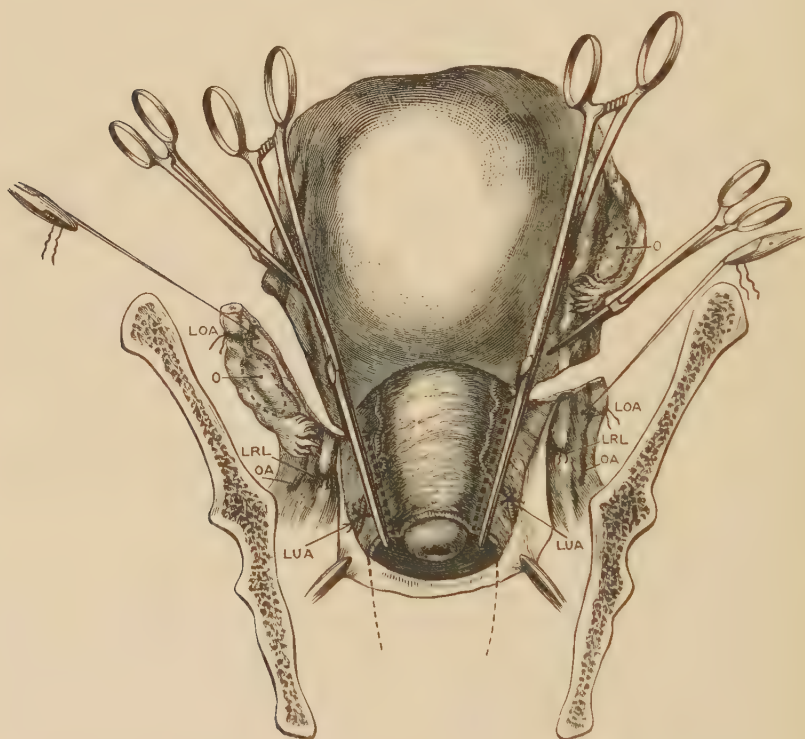
Mr. E. S. Bishop (*Uterine Fibro-miomata*, 1901, p. 304), writing on the subject of hernia after hysterectomy for fibroids, says: "Since drainage through the abdominal wound has been entirely given up, and special care has been directed to the suture of the fascia, I have only seen one hernia, and that followed suppuration in the wound due to an imperfectly asepticated suture." As showing the frequency of hernia after the extra-peritonæal method, Mr. Cullingworth's experience may be quoted. Of ten cases so treated by him, two died, and five

subsequently suffered from hernia in various degrees (quoted by Mr. Bishop, *loc. supra cit.*, p. 221).

(3) Another weak point in the operation is the risk of septic absorption attending the necessary sloughing of the stump.

(4) It is not easy to compare the mortality of the two operations, as the intra-abdominal method is applicable to a very large number of cases that could not be dealt with by drawing up the stump into the

FIG. 352.



Abdominal panhysterectomy seen from the front. Final stage. (Galabin.)

The uterine arteries have been tied, and thin clamps placed upon the remaining parts of the broad ligaments, posterior and anterior vaginal fornices being opened. The dotted lines show the lines of incision to separate the uterus. L O A, ligature on ovarian artery; L R L, ligature on round ligament; L U A, ligature on uterine artery; O, ovary; O A, ovarian artery.

abdominal wound. Mr. Thornton, with a considerable experience of the extra-peritonæal method of treatment of the stump, stated that the mortality of his cases was just under 8 per cent. This included all his early cases. Practice with the serre-nœud reduced his mortality by fully one-half; and he considered that "cases suitable for the serre-nœud, in which there are no unusually severe complications, may fairly be said to have a mortality of only 3 or 4 per cent." (*loc. supra cit.*, p. 621).

The intra-abdominal method, with a much wider range of cases and

including all kinds of complications, has given better results than this, and in the hands of expert operators has yielded a death-rate as low as 2 per cent.

(iii.) **Total Hysterectomy.**

This may be called for in certain cases, when the uterus, for instance, is the seat of malignant growth, or when the position of a fibroid tumour does not permit of division through the cervix.

The operation is similar to that of partial hysterectomy as far as the ligature of the uterine arteries.

Opening of Vagina.—These arteries having been secured, the tumour is held forward, and an opening is made through the bottom of Douglas's pouch into the posterior fornix, upon the end of a pair of forceps previously introduced through the vagina. A finger is then passed through the opening thus made, and carried forward across the cervix to act as a guide to the opening of the anterior fornix. The position of the already reflected bladder is then carefully noted, and the vagina again opened with scissors upon the finger in the anterior fornix. The anterior and posterior incisions are next freely lengthened, leaving the lateral attachments only of the vagina to the uterus. These should be secured with clamp forceps, and the uterus removed by incisions carried between the forceps and the cervix. The forceps are then removed, one at a time, and a careful examination made for any bleeding points, which should be secured and tied separately.

Closure of Peritonæum.—The next step is to unite the cut edges of peritonæum, and thus shut off the opening into the vagina from the peritonæal cavity. An iodoform gauze plug is introduced into the vagina from above, and drawn down until its upper end is level with the cut edges of the vagina. The operator then proceeds to approximate the edges of the peritonæum with a continuous suture. Having sewn together the two layers of the lower part of the broad ligament on one side, the anterior peritonæal flap is brought over the vaginal opening and secured to the posterior cut edge of peritonæum, the operation being completed by the closure of the broad ligament on the remaining side.

Dr. Howard Kelly's Method of performing Partial Hysterectomy (Hystero-myomectomy).

Dr. Kelly adopts a different procedure from that described above. Instead of tying and dividing the broad ligaments on both sides before severing the pedicle, he works across the pelvis from one side to the other, dividing first one broad ligament, then the pedicle, and finally dealing with the other broad ligament.

The stages of the operation as described by him (*loc. supra cit.*, p. 368) are shortly as follows:—

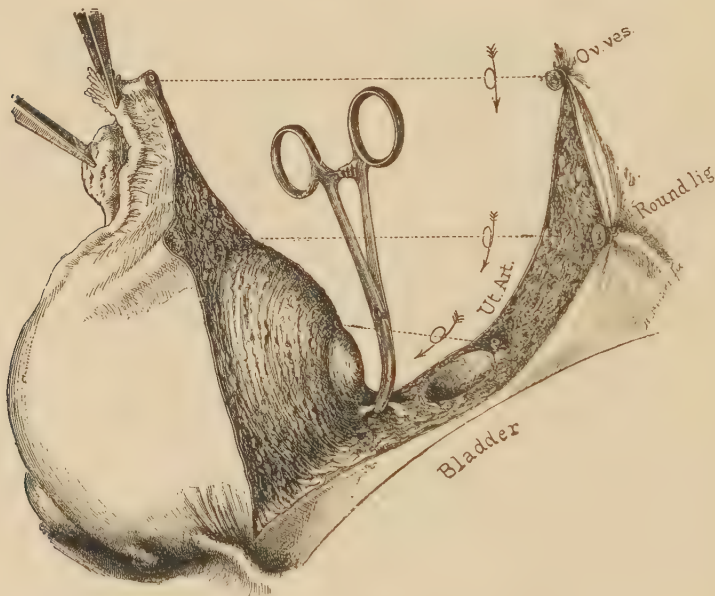
- (a) **Preliminary Preparation of the Field of Operation, including the Skin and Vagina.**
- (b) **Opening the Abdomen.**
- (c) **Delivering the Tumour if possible.**
- (d) **Ligation of the Ovarian Vessels and Round Ligament of one side, usually the left.**

In a woman under forty years of age he considers it better to leave both ovaries in the pelvis, with or without the uterine tubes. The broad ligament is divided between two sets of ligatures, or between

forceps on the proximal and ligatures on the distal side, as previously described.

(e) **Detachment of the Vesico-uterine Fold of Peritonæum.**—The uterus being drawn back, “the anterior loose peritonæal fold along the curved line of the utero-vesical reflection is cut through from round ligament to round ligament. As the bladder is raised, the loose cellular tissue beneath it is exposed, and it may be still further freed by a rapid dissection with knife or scissors.” The separation of the bladder is completed by pushing it well down with a sponge firmly compressed

FIG. 353.



The operation of hystero-myomectomy. (Kelly.)

By a continuous incision from left to right, ligating or clamping—at the points indicated by the arrows—first the left ovarian vessels (Ov. ves.), next the round ligament, and then the left uterine artery (Ut. Art.). Finally, the cervix is cut across, and the uterus pulled away until the right uterine vessels are exposed.

in sponge-forceps, until the cervix is bared almost or quite down to the vaginal junction.

(f) **Ligation of the Uterine Vessels of the same side.**—These vessels are now securely tied close to the cervix by a silk ligature on a curved needle passed close to the cervical tissue, but not entering it.

(g) **Amputation of Uterus in Cervical Portion.**—The uterus is now drawn to the other side, and the uterine vessels are divided from 6–10 mm. above the ligature, an assistant being ready with artery-forceps to grasp any bleeding vessel left by chance out of the ligature. The uterus is now completely divided in its cervical portion, at a point just above the vaginal junction, and in such a way as to leave a cup-shaped pedicle. It is a good plan, when the cervix is nearly divided, to cut upward for one or two centimetres so as to leave behind a thin shell

of cervical tissue, and expose the opposite uterine vessels at a higher level, when it is much easier to tie them without risk of including the ureter.

(h) **Clamping the Uterine Vessels of opposite side, the Round Ligament, and the Ovarian Vessels, followed by Removal of the Tumour.**—As the uterus is drawn up and rolled over on to its side, the uterine vessels come into view; these are seized in clamp forceps and divided. The uterus is rolled over still more till the round ligament is seen. This is clamped and divided, and is followed by similar treatment of the ovarian vessels. The whole mass is thus freed and taken away.

(i) **Application of Ligatures in place of Forceps.**—The parts now held in forceps (the ovarian vessels, the round ligament, and the uterine vessels) are successively tied with firm silk ligatures and the forceps removed.

(j) **Suturing the Cervical Stump.**—The stump is carefully examined for any bleeding points, which should be tied. It is now closed over the cervical canal by passing from three to five or more catgut sutures in an antero-posterior direction, and tying each one as it is passed. By suturing in this way the cup-shaped pedicle is changed into a transverse linear wound. Should there be a discharge of pus from the uterus or a muco-purulent plug in the canal, this latter should be wiped out with gauze as soon as cut across, and afterwards dissected out with a sharp knife and forceps.

(k) **Covering the Wound-area with Peritonæum.**—The large flap of peritonæum which lies in front of the pedicle is drawn over the stump and sutured to the posterior peritonæum by a continuous suture.

CANCER OF THE UTERUS.

Cancer of the Body.—In cases suitable for radical treatment the uterus may be removed, either through the vagina or by an abdominal incision, the choice of route being determined by the size of the body. The indications for operation are practically the same as those given in the next section, on cancer of the cervix. Should the abdominal route be chosen, the operation is in all essentials similar to that described for fibroids, the whole of the uterus being of necessity removed. Hysterectomy by the vaginal route is similar to that described for carcinoma of the cervix.

Vaginal Hysterectomy for Carcinoma of the Cervix.

To determine whether Case is suitable for Removal of the Uterus.—It is not easy in a case of cancer of the cervix to say whether the whole disease can be eradicated, as growth may have extended beyond the limits of the uterus, and yet be inappreciable on the most careful examination.

To determine whether a case is operable, the different routes by which the growth may advance must be carefully borne in mind, and a systematic examination made of each. They are as follows:—

(1) The growth may involve the fornices or extend down on to the vaginal walls.

(2) It may extend forwards and involve the bladder.

(3) It may extend outwards in the broad ligaments,

(4) Or extend backwards in the utero-sacral folds and involve the rectum.

In examining a case the first thing to be noted is the mobility of the uterus. This may be tested most efficiently by fixing a pair of tenaculum forceps into the cervix, and observing whether the organ can be drawn down readily towards the vulva. If there is complete or considerable fixation and wide extension of growth in any of the above-mentioned directions the case is inoperable, and should be left alone. The cervix should be examined, not only digitally, but through a speculum, and the extent to which the fornices or the walls of the vagina are involved carefully noted. To determine whether extension laterally in the broad ligaments or backwards in the utero-sacral folds has taken place, the vaginal examination must be supplemented by a rectal one, and a search made for any masses or thickening in these situations.

If the uterus is freely movable, and can be pulled down to the vulva, and there is nothing to be felt in the broad ligaments or utero-sacral folds, the case is a favourable one for operation, and there are good grounds for hope of permanent relief.

But between the eminently favourable cases and those that are to be regarded as inoperable certain cases are to be met with, not infrequently, in which there exists an element of doubt as to whether the growth can be entirely removed. On this point Dr. Howard Kelly's remarks are worth quoting: "In concluding whether or not to operate, the patient should in all cases have the benefit of any reasonable doubt, and the operator must not be too exacting in restricting his indications. I have operated several times where the disease was found so advanced that there could be no reasonable question but that some portion of it was left behind, and this was confirmed by a microscopic examination of the specimen, which showed cancer cells right up to the cut edge of the broad ligament, and yet one of these patients enjoyed perfect health for five years, when the disease reappeared in the glands of the neck; another had a local return after three years of good health, and two others are living, apparently in perfect health, three and four years after the operation" (*loc. supra cit.*, p. 319).

Is an operation justifiable in cases in which no hope can be reasonably entertained of a permanent cure? In considering this question, the influence that repeated losses of blood and continuous septic absorption from the breaking-down cancerous mass have on the health of the patient should be borne in mind. If under the circumstances there is reason to think that the uterus can be removed without unusual risk, the surgeon is justified in operating after laying the facts of the case fairly before the patient. For recurrence of the disease, so long as it does not take place in the vaginal roof, will be attended with less pain, an absence of hæmorrhage, and a relief from the distress dependent on a fœtid discharge.

No radical operation should be undertaken if extension of growth has led to involvement of bladder, ureters, or rectum. Wide extension into the broad ligaments will give rise to grave danger of injury to the ureters. Moreover, difficulty will be experienced in the application of ligatures or forceps, which are, further, likely to slip off from the friable cancerous growth.

Palliation may be afforded in some inoperable cases by a free scraping away of the growth in the cervix, followed by the application of Paquelin's cautery. Great hopes of relief should not be held out to the patient as likely to follow this procedure, nor should the operation be urged on her. Whilst considerable benefit follows in some cases, in others, and especially when the growth is very advanced, scraping has done more harm than good by hastening communication with the bladder and other organs.

Operation.—There are many modifications in the various stages of this operation adopted by different surgeons, the chief of which is the treatment of the broad ligaments, some preferring to tie these with silk or catgut, others to clamp them.

Preliminary Treatment.—For some days beforehand the vagina should be freely douched with some antiseptic lotion, such as 1-500 formalin.

For the operation the patient is placed in the lithotomy position, and the legs secured by means of a Clover's crutch. The perinæum is retracted with a Sim's or Simon's speculum. Lateral retractors may be found useful at certain stages of the operation. The cervix is drawn down to the vulva by vulsella, one pair of forceps being applied, as a rule, to the anterior lip, one to the posterior. The point of attachment will, however, depend to some extent on the condition of the cervix. In the case of large cauliflower excrescences it will often be found necessary, as a preliminary to freeing the uterus, to remove the growth freely with scissors and sharp spoon. Some surgeons prefer, in all cases in which there is exposed cancerous growth on the cervix, to remove it before commencing the operation. This procedure is based on sound principles. In the removal of cancer elsewhere in the body, every precaution that is possible is taken against the reinfection of the wound surfaces by cancerous material. That raw surfaces may be inoculated in this way is abundantly proved by clinical and experimental evidence. Mr. Herman, amongst others, recommends that all exposed growth should be thoroughly scraped away with a sharp spoon until firm tissue is reached. A Paquelin's cautery is then applied to the whole surface. By this means the chance of reinfection of the operation wounds is greatly minimised (*Dis. of Women*, p. 380). In Dr. Baldy's *Gynæcology* (1894, p. 389) it is further recommended that the funnel-shaped excavation made by the spoon and cautery be stuffed with iodoform gauze, and the lips of the cavity sewn together by means of a continuous suture.

Separation of Bladder.—It is not a matter of great importance whether the surgeon begins by separating the bladder or by opening Douglas's pouch. If he choose the former, the line of reflection of the bladder from the cervix is ascertained by passing a bladder sound, or, as Mr. Herman recommends, by grasping the mucous membrane and noting the line at which you begin to be able easily to pull it from the uterus.

With a blunt-pointed pair of scissors the mucous membrane of the anterior fornix is incised in the median line just below the line of reflection of the bladder, and the incision prolonged laterally so as to surround the cervix in front. The operator cuts down until the wall of the uterus is reached, and then proceeds to strip off the bladder from the

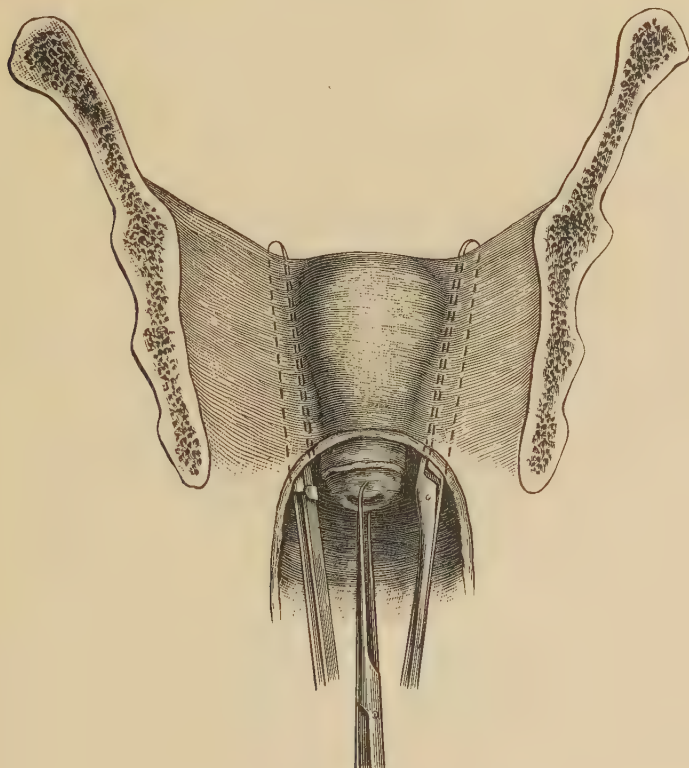
front of the cervix with the fingers, keeping close against the uterus the whole time. Any bands that resist separation by the fingers may be divided with scissors. It is most important that this separation be extended well to the sides of the uterus, for by doing so not only is the bladder saved from chance of injury in the subsequent manipulations, but the ureters are pushed well out of the way. The anterior peritonæum having been reached, is opened by pushing a sound or blunt pair of forceps through it, or divided carefully with a pair of scissors, the opening being subsequently enlarged with the fingers. In some cases, on account of peri-uterine inflammation, difficulty may be experienced in separating the bladder from the uterus, and considerable risk incurred of opening the former. Should this happen, the injury should be at once repaired. If growth is found to have extended forwards and involved the walls of the bladder, the operation may have to be discontinued. If the amount involved is small, has not involved the ureters, and there is not wide extension of growth in other directions, a portion of the bladder-wall may be removed, the opening being sutured subsequently with catgut.

Opening Douglas's Pouch.—An incision is next made through the mucous membrane of the posterior fornix, so as to open Douglas's pouch. It is prolonged laterally so as to meet the extremities of the anterior incision, care being taken not to cut so deeply as to wound the uterine arteries. There is no fear of this, if the incision at the sides is made through the mucous membrane only. In making the posterior division the cervix should be held well forward by the vulsella, and the points of the scissors directed towards the uterus to avoid risk of injury to the rectum. With care there is no great risk of this accident, unless the posterior fornix has been much encroached on by the growth. The opening in the peritonæum is then prolonged laterally with scissors, or, as some prefer, enlarged by tearing with the two forefingers. A difficulty met with at this stage in entering Douglas's pouch may be due to the incision being carried through the mucous membrane only, and the peritonæum separated and pushed before the finger. It is unnecessary to pass a sponge through the posterior opening into Douglas's pouch, as recommended by some operators, unless actual protrusion of intestines takes place. Any bleeding points in the cut edges of the vagina should be secured by pressure-forceps. A fear of hæmorrhage occurring some hours after the operation has led to various modifications of this part of the operation. In Dr. Baldy's work (*loc. supra cit.*, p. 389), for instance, it is recommended that the peritonæum be sewn to the cut edge of the vagina by a continuous catgut suture; and Dr. Sinclair (Allbutt and Playfair, *Syst. of Gyn.*, p. 688) ligatures the vaginal wall before dividing it. By these proceedings, the operation is unnecessarily complicated, and they are not required as a routine measure.

The Management of the Broad Ligaments.—This stage of the operation is the one that has met with the greatest variety of treatment at the hands of different surgeons; and it is not difficult to see the reason of this. The inconveniences connected with long silk ligatures, the dangers attendant on the use of clamps, the advantages or disadvantages of closing the vaginal vault, have influenced in various degrees different operators in the choice of one variety or another. I will first describe the method of securing the broad ligaments by sutures. For

this purpose a needle curved in a plane nearly at right angles to the handle is made use of, or two may be employed, curved respectively to the right and left for the corresponding broad ligaments. Commencing at the lower part of these structures, and working first on one side, then on the other, successive portions are tied with silk and divided. As the division proceeds, the uterus is pulled lower and lower, first of all the cervix and then the body being freed from its lateral attachments. Dr. Galabin (*Dis. of Women*, 1893, p. 323) points out

FIG. 354.



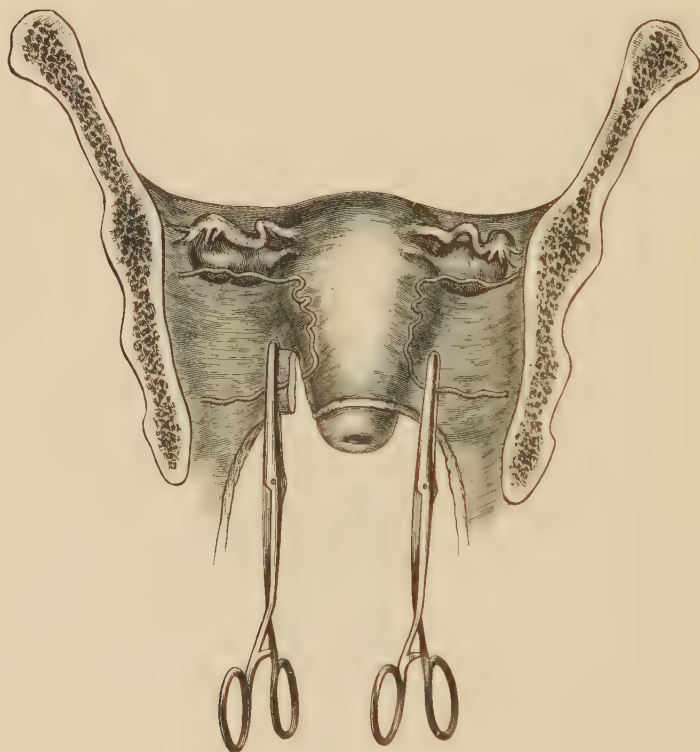
Vaginal hysterectomy with clamps. (Baldy.)
Single clamp operation.

that "as soon as the centre of the uterus is divided from the utero-sacral ligaments, the fundus can generally be drawn down much further and the upper part of the broad ligament brought within reach."

The tying of the upper part of the broad ligaments is facilitated by seizing the fundus with vulsella, retroflexing it, and dragging it out through the posterior opening made into Douglas's pouch. By this manipulation the upper parts of the broad ligaments are brought within easy reach, and are readily transfixed by a double ligature and tied in two halves. If silk is made use of for the ligatures, the ends should be left long to facilitate their removal. The use of this material, however, presents certain disadvantages. If the ends are left long, and the

stumps cannot be drawn down and fixed in the vaginal roof, so as to render them extra-peritonæal, the silk strands serve as a track along which infection may spread upwards from the vagina. If cut short and left in the pelvis, they are very likely to serve as septic foreign bodies, round which accumulations of pus may take place. In their stead catgut has been recommended as being absorbable, and, further, as being less likely to slip than silk. These are cut short, whether left within or outside the peritonæum. The objections to ligatures, whether silk or

FIG. 355.



Vaginal hysterectomy with clamps. (Baldy.)
Multiple clamp operation : first step.

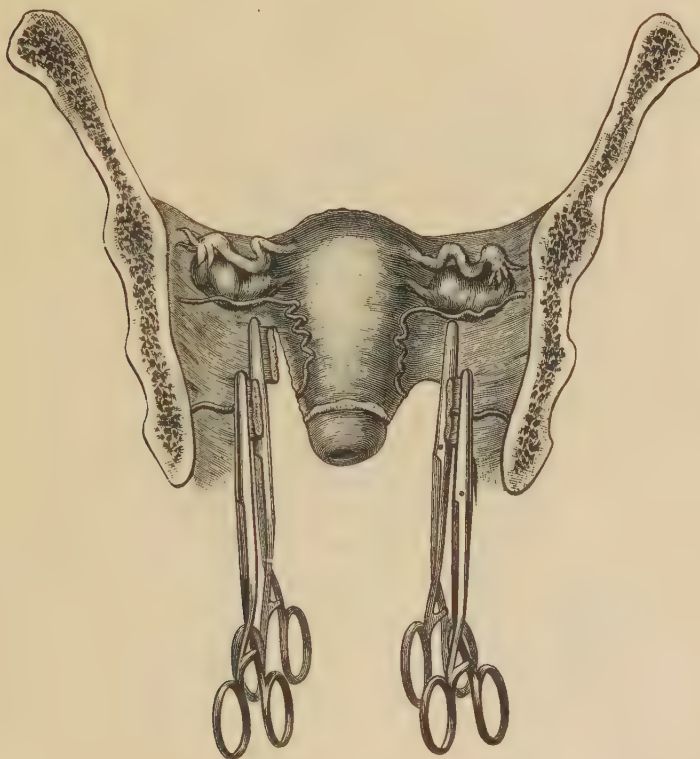
catgut, are these: they are more difficult to apply than clamps, and the operation takes longer. Whether ligatures or suitable clamps, properly applied, are the more liable to slip is a point difficult to decide; secondary hæmorrhage may result from the use of either. The greatest objection to the ligature is the fact that, whatever precautions are taken, it may serve as a septic foreign body. Not even the catgut ligature is free from this reproach. A point in favour of tying the stumps is that these latter can be drawn down into the vaginal vault, and thus rendered entirely, or almost entirely, extra-peritonæal. The method of doing so will be referred to later.

Although an equal number of objections may be urged against the use

of clamps, I prefer this latter method of operating, largely on account of the greater ease and rapidity of procedure.

Against their use it has been urged that they prevent closure of the vaginal vault, and that the large open channel thus left invites contamination of the pelvic peritonæum. But this open space provides such free drainage that peritonitis is a very rare accident, and pelvic abscess is seldom seen. It is thought that there is a greater risk of including the ureter in the grasp of the forceps, or a danger of

FIG. 356



Vaginal hysterectomy with clamps. (Baldy.)
Multiple clamp operation : second step.

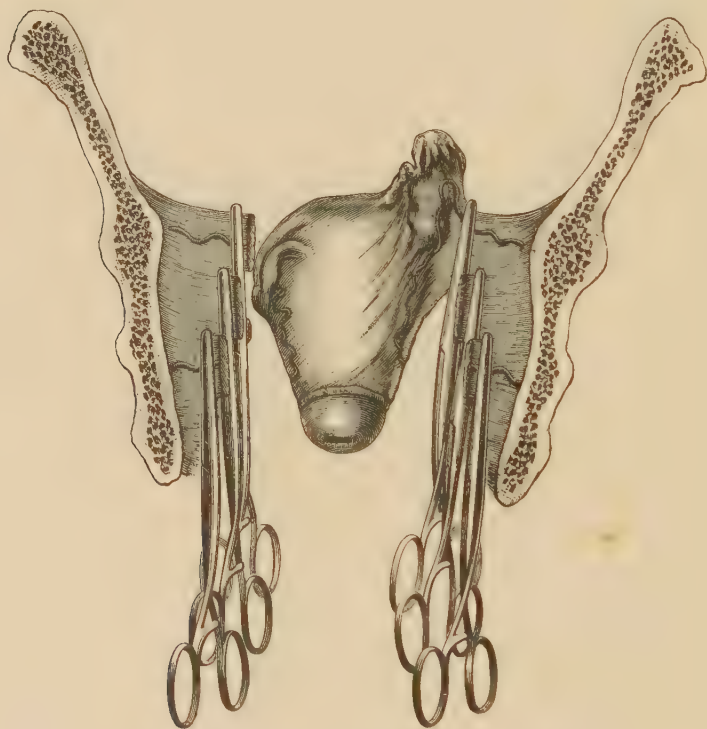
catching the intestine in the points of the forceps. This latter may be avoided with care, and the former accident by freely separating and pushing aside the soft parts at the side of the uterus.

Numerous forms of forceps are employed for clamping the broad ligaments. The ones I prefer are Doyen's, with strong spring blades, which come into close apposition when closed. Either one long pair (Fig. 354) may be applied on each side, embracing the whole ligament, or two or more shorter pairs may be employed (Figs. 355, 356, 357). The latter method is, I think, preferable to the former. It is easier to apply the forceps to a half or less of the broad ligament than to the whole of it; there is less risk of slipping, and as the uterus is separated

from its attachments and brought lower down, there is less risk of catching a loop of intestine in the ends of the blades. There is less objection to the single-clamp operation if the broad ligaments are short and the finger can readily be passed beyond them; but when they are long and the upper border cannot be felt, the forceps should be applied no farther than the finger can reach, the upper part of the ligament being secured by a second pair.

In applying the forceps the front and back of the ligament are carefully examined by the finger, to make certain that the bladder has

FIG. 357.



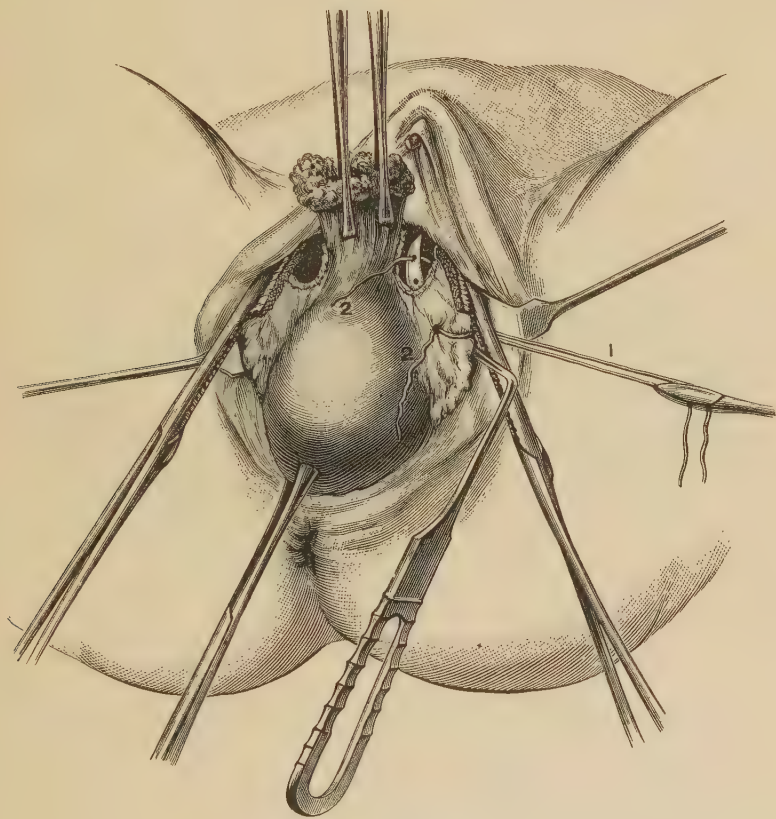
Vaginal hysterectomy with clamps. (Baldy.)
Multiple clamp operation : third and final step.

been well separated at the sides, and that there is no intestine in close contiguity. With one finger in front and another behind the broad ligament, the two blades of the forceps are guided into position, and the parts being again carefully examined, tightened up. If the entire ligament is to be secured in the grasp of one pair, they must be passed beyond its upper border, and care taken that no intestine is included.

A similar proceeding is carried out on the opposite side. The forceps having been applied, the ligament is divided between the forceps and the uterus. If the clamps have embraced a part only of the broad ligament on each side, a second pair are now applied, and

the uterus thus separated in successive portions. The operation as performed by Dr. Galabin consists in a combination of these two methods (*Dis. of Women*, 1903, p. 429). He clamps the lower half of the broad ligament, and ties the upper half. The bladder having been separated in front and Douglas's pouch opened behind, as described above, a clamp is applied on each rib to the lower half of the broad ligament, reaching a little above the centre of the uterus. The uterus

FIG. 358.



Vaginal hysterectomy. (Galabin.)

Fundus retroflexed and drawn down externally. Double ligature passed through upper half of left broad ligament. One loop tied (1). End of second loop (2) being passed round broad ligament by curved pedicle needle,

is then cut away on each side as high up as the tips of the blades. The next step is to draw down the fundus through the opening in Douglas's pouch (Fig. 358) by means of vulsella. The upper half of the broad ligament is now within reach. It is transfixed on one side by a pedicle needle threaded with silk and tied in two halves. The uterus, now cut away on one side, is left attached by the upper half of the opposite broad ligament, which is tied and divided in the same way. The pedicles of the broad ligaments are finally secured to the edges of the

opening in the vaginal vault in the way described in the next paragraph, the ligatures which have secured them being left long for this purpose. This mode of performing the operation is a most satisfactory one. It avoids the risk that ligatures applied to the lower half of the broad ligament have of slipping and the difficulties that often attend the application of forceps to the upper half. To allow of retroflexion of the uterus and the drawing of the fundus through the vaginal vault, care must be taken that the clamps are not applied too high up on the broad ligaments. A cervix greatly elongated or enlarged by disease, an enlarged body, or a small opening in the vaginal vault, may prevent the operation being terminated in this way. The uterus should then

FIG. 359.



Vaginal hysterectomy with the ligature-stumps drawn into the vagina, with sutures in place ready to close the opening in the vaginal vault. (Baldy.)

be drawn down as far as possible and the remainder of the broad ligament secured with clamps.

Closure of Vault of Vagina.—In this, as in the other stages of the operation, practice varies widely, some surgeons employing no sutures at all, others partially or entirely shutting off the peritonæal cavity. Where silk ligatures are employed the stumps should, if possible, be rendered extra-peritonæal. This is effected as follows:—

By means of the ligatures, which have been left long, the pedicle on one side is pulled down below the level of the cut edge of the vagina and fixed in position by two or three catgut sutures. The same proceeding is carried out on the opposite side (Fig. 359). By this means the peritonæal cavity is almost entirely shut off, a small opening only being left in the centre of the vault for drainage. Even this is dispensed with by some surgeons, the vaginal wound being completely closed by the insertion of one or two stitches in the median line (Fig.

359). By the employment of catgut, Olshausen has been enabled to completely close the peritonæal cavity, leaving the stumps in the pelvis. The gut ligatures are cut short and the pedicles allowed to retract within the peritonæal sac. The wound is then closed by sutures passed from before backwards through the edges of the anterior vaginal wall, the anterior layer of peritonæum, the posterior peritonæum, and the posterior wall of vagina. His success has not been obtained by others who have followed his methods. Dr. Sinclair (*loc. supra cit.*, p. 690) says: "After Olshausen's success in completing the operation by cutting short the broad ligament ligatures, and completely closing the wound in the pelvis, I tried for a time to do without drainage, but found the result unsatisfactory. Several times, owing to unfavourable symptoms which followed, it was necessary to undo some stitches in order to permit of the escape of retained fluid." Considering the difficulties of cleansing the vagina, there must always be some risk of infection during the operation, and it appears on the whole safer to provide for drainage of the pelvic pouch, especially when ligatures are left within it. When forceps are employed the stumps cannot be rendered extra-peritonæal. If at the time of operation there appeared to be a tendency to prolapse of the intestines, a stitch or two might be inserted in the centre of the vaginal roof; but otherwise they are not necessary.

After-treatment.—After the removal of the uterus, the vagina is loosely packed with a strip of iodoform gauze, and if forceps are used the gauze should be wrapped round their handles where they lie in contact with the vulva. The forceps are removed at the end of thirty-six hours, and the plug of gauze renewed. When sutures are employed the gauze plug may be left in three or four days. No douche should be employed for five or six days after the operation.

Abdominal Hysterectomy for Carcinoma of the Cervix.—This operation has been extensively practised of late years as a routine method of treatment. It allows of a more thorough removal of the pelvic cellular tissue and enables one to detect and remove any enlarged glands. The uterus, moreover, can be freed from the bladder more easily from above, and the detachment can be carried lower down on the vaginal walls. The mortality, however, remains considerably higher than that for the vaginal operation, being at least 15 per cent. as compared with 5 per cent. for the latter method. Sufficient time has not elapsed yet to allow for a comparison of the results of the two operations. It would appear at the present time better to adopt the vaginal route for removal of the uterus when the growth is early and is confined to the cervix. Abdominal hysterectomy is suitable to cases where the growth is more advanced and yet appears possible of removal. There is no doubt that cases can be successfully dealt with by the abdominal route that one would not deal with by vaginal hysterectomy. The former method should be adopted when the body is much enlarged, and I think it preferable to extensive division of the passages, when the vagina is very small.

The operation in its essentials is the same as that described for the removal of the uterus for fibro-myomata. Before commencing the abdominal operation, the growth in the cervix should be removed freely with curette and cautery, and the cavity plugged with iodoform

gauze. The chief features of the operation as performed for carcinoma are as follows:—

(1) The ovarian vessels and round ligaments are tied and divided well out towards the pelvic brim, and the broad ligament divided.

(2) The bladder is separated for an inch or more from the upper part of the vaginal wall.

(3) The position of the ureters should be ascertained and the uterine arteries tied as far out as possible. The ureter should not be dissected bare, as it is liable to slough from interference with its blood supply.

(4) The pouch of Douglas is opened into the vagina, and the uterus removed with the upper inch or more of the vagina, which has been stripped from the bladder and rectum. Right-angled clamps applied to the vagina before division will help to prevent infection from the cancerous cervix.

(5) Search is then made for glands along the course of the iliac vessels.

(6) A plug is passed into the vagina, and the cut edges of peritonæum brought together and sutured over it.

The risks attached to this operation are hæmorrhage, sepsis, injury to the ureters or bladder, the former being sometimes tied or divided, and infection of the urinary tract.

CÆSARIAN SECTION.

Indications.—(1) An extreme degree of pelvic contraction, when the smallest diameter through which the child has to pass is less than two inches.

(2) Solid tumours of the pelvis or uterus, which cannot be pushed out of the way; cancer of the cervix and cicatricial contraction of the passages.

(3) In any case in which there is no hope of obtaining a living child, even by the induction of premature labour, it is reasonable to offer the mother the option of undergoing a somewhat greater risk to save the life of the child.

Time of Operating.—There are three possibilities: (1) To wait until labour comes on spontaneously. (2) To operate at a certain fixed time before the commencement of labour pains. (3) To induce labour by the passage of a bougie and operate at a pre-arranged time.

The great objection to waiting for the onset of natural labour is that the operation may have to be performed at night, often without the necessary assistance and with the patient imperfectly prepared. For these reasons many surgeons prefer to operate at a definite time, which is arranged for a few days before full term. This is undoubtedly the most satisfactory plan. The operation can be undertaken in daylight, the needful assistance is forthcoming, and the patient can undergo the proper preliminary treatment—as necessary in Cæsarion section as for any other abdominal operation. The chief objection made to operating before the onset of labour is that the uterus may not contract well, with the risk of hæmorrhage that imperfect contraction entails. Practical experience has, however, shown that the fear of uterine inertia and bleeding is unfounded. If the surgeon prefers to

operate after labour pains have commenced, he may still do so at a pre-arranged time by passing a bougie over-night. It is possible that the pains may not come on by the time arranged. Under these circumstances he must either defer his operation until they appear, which may be at a most unsuitable time, or operate without pains. The latter alternative is the better one. Dr. Kelly says that he has met with no such accident as the failure of the uterus to contract and hæmorrhage as the result of operating without waiting for the pains to come on (*loc. supra cit.*, vol. ii. p. 417).

Operation.—The patient is prepared as for ovariectomy, attention being paid to the diet, the regulation of the bowels and the points previously mentioned. The abdomen is thoroughly cleansed, and the vagina douched with 1-1000 sublimate solution or other antiseptic. There should be two assistants in addition to the anæsthetist, one to stand opposite the surgeon and assist in the various manipulations, the other to hand instruments, whilst someone, in addition, should be present who is competent to attend to the child when delivered.

Abdominal Incision.—The incision through the abdominal wall should be six inches long, of which about a third will be above the umbilicus, whilst the lower end should not be nearer than two or three inches to the pubes. The incision is made deliberately in the median line, as already described in the operation for ovariectomy, all bleeding points being carefully arrested. The peritonæum, being reached, is picked up and opened, and then divided on the fingers for the full length of the skin incision. In dividing this structure downwards towards the pubes, the fingers, used as directors, will serve to detect the bladder if this is much drawn up—a complication most likely to be found when labour has been protracted. It has been the custom to employ the rubber tube introduced by Müller to control hæmorrhage from the uterus during the operation. This tube, which is about a yard long, is passed over the fundus of the uterus and adjusted round its lower segment. By its employment the loss of blood during the operation is very slight, and the surgeon may be as deliberate as he pleases. If applied for too long it has the grave disadvantage of producing uterine inertia and hæmorrhage from interference with the blood-supply to the muscle. When competent assistance is at hand, the operator will, therefore, do well to discard it, and trust, if hæmorrhage is severe, to compression by the assistant's hands of the broad ligaments against the lower uterine segment. If good assistance is not obtainable, it may be thrown round the uterus as a precautionary measure, to be employed if necessity arises. The next step is the opening of the uterus, and this and the following stages in the operation should be performed as rapidly as possible.

Incision of Uterus.—The assistant should, as recommended by Mr. Herman, place a hand on each side of the abdominal wall, and press it downwards and backwards, so as to make the wound gape and prevent fluid entering the peritonæal cavity. The surgeon cuts through the uterine wall at one spot till the membranes are reached, and then rapidly enlarges the incision up and down till it is nearly the length of the abdominal incision, that is, nearly six inches long. If the placenta is beneath the incision it is usually recommended that it be cut through. Dr. Kelly thinks this a mistake, and recommends that the nearest

border be sought for and the membranes opened there. Hæmorrhage is usually moderate, unless the placenta is attached to the anterior wall. If from this cause the bleeding is alarming, it should be controlled by an assistant grasping the lower part of the uterus and compressing the broad ligaments, or by tightening the elastic ligature if this has been previously applied.

Extraction of Child.—The uterus having been opened, the surgeon introduces a hand and seizes a knee or foot and delivers the child. It has been recommended, on account of occasional trouble in the extraction of the after-coming head, that this should be delivered first. It is not, however, easy to grasp, and will probably require both hands, which take up more room than is convenient in the uterine wound. Difficulty in extraction of the head is generally due to too small an incision in the uterine wall. The child having been delivered, the funis is tied and divided, or time may be saved by clamping it temporarily and tying the foetal end after division. After the removal of the child, the uterus, being sufficiently diminished in size, is brought out through the abdominal wound, and a large flat sponge or gauze swab placed behind it. If the elastic ligature is employed, it may now be tightened up, but, on account of the objections given above, its use is not recommended under ordinary circumstances, compression by the assistant's hands being employed instead. The placenta and membranes are then carefully peeled off the uterine wall and removed, and the interior of the uterus mopped over with 1-1000 sublimate solution. If the uterus does not contract readily, it should be stimulated to do so by compression.

Uterine Sutures.—Both silk and catgut sutures are employed for this purpose. Though catgut has been largely used, one or two cases have been recorded where ligatures of this material have given way, an accident I have seen happen. On the other hand, silk ligatures may become infected and lead to sinuses. On the whole, stout catgut that will not become absorbed too soon appears to be the best material. About ten deep sutures should be inserted half an inch or rather more apart. They are introduced half an inch from the edge of the wound on a half-curved or fully-curved needle, and are brought out on the cut surface close to, but not including, the decidual surface of the uterus. These are tied tightly, and if bleeding is free it is a good plan to secure some of the ligatures before they are all introduced. Superficial gut sutures are then employed to bring into apposition the cut edges of the peritonæum.

Sterilisation of Patient.—To within the last few years the usual practice was to sterilise patients when the condition requiring Cæsarian section was one which could not be remedied. At the present time many surgeons are opposed to this practice. On ethical grounds it has been held that the responsibility for future pregnancies does not rest with the doctor, and in Dr. Herbert Spencer's words "that it was his duty to deliver the woman and restore her as nearly as possible to a natural condition, a result obtained by the conservative operation without sterilisation" (*Obstet. Trans.*, 1904, vol. xlv. p. 334). One strong point against sterilisation is that the child may die, and that the mother's chances of further pregnancy have been destroyed. On the other hand, the mortality of the operation is about 8 per cent., that for second operations being about the same as that for the

first. Consequently in repeated operations the patient runs a considerable risk. There is further the danger of rupture of the uterus, and that this is a real one is shown by the number of cases reported of this accident. If sterilisation is decided upon it is performed as follows :— The tube being picked up, a double ligature, threaded on a pedicle needle, is passed through the broad ligament a sufficient distance below it. The loop having been divided, the two strands are interlocked, and one is tied round the tube close to its uterine end, whilst the other is tied round the free edge of the broad ligament beyond the fimbriated extremity. The ovary should not be included in the ligature, which should be carried between it and the Fallopian tube. The tube is then cut away between the two ligatures.

The subsequent stages of the operation and the after-treatment are similar to those described in the operation of ovariectomy.

PORRO'S OPERATION.

Porro's modification of Cæsarian section consists in supra-vaginal amputation of the uterus and fixation of the stump in the lower angle of the wound. But under this heading are now included partial hysterectomy with intra-peritonæal treatment of the stump and total hysterectomy.

The simplest method, and the one best adapted for those inexperienced in abdominal surgery, is the operation devised by Porro. It has received various modifications, and that described by Mr. Herman (*Difficult Labour*) after the method of the late Mr. Lawson Tait, may be regarded as the best on account of the simplicity of its details and the few instruments required.

The abdomen having been opened, as described in Cæsarian section, a rubber tube, two feet long, is slipped over the fundus and adjusted round the lower part of the uterus. The ends of the tube are tied in a single hitch, and prevented from slipping by being grasped in a pair of forceps. The uterus is then opened at one point, and the incision enlarged by tearing with the fingers. The child is then extracted. The uterus is now brought out of the abdomen, the ligature tightened if necessary and tied a second time. Two knitting needles are passed from side to side through the flattened rubber tube and the cervix, and the uterus cut off about three-quarters of an inch above the needles. The abdominal wound is sewn up with interrupted silkworm gut sutures about two-thirds of an inch apart, the lowest stitch being passed through the stump below the elastic ligature, as well as through the abdominal wall. The stump is dressed with iodoform and tannic acid powder, and covered with a layer of dry dressing.

This operation carries with it the risks and disadvantages already mentioned in the section on hysterectomy, and the expert operator will prefer, after removing the uterus, to treat the stump by the intra-peritonæal method. The details of this operation are similar to those mentioned above in the removal of the uterus for fibroids.

Indications for the operation are as follows :—

1. Failure of the uterus to contract after removal of the child.
2. Injuries to the uterus sustained in efforts to deliver through the pelvis, such as rupture.

3. The fact that the operator is inexperienced. In this case he should adopt the method of amputation with fixation of the stump in the abdominal wound, as described above.

Removal of the uterus may be indicated in the radical treatment of the condition giving rise to the obstruction. This gives such further indications as follows :—

4. When the uterus contains myomatous tumours which block the pelvis, or which cannot safely be removed by myomectomy (Kelly).

5. When there are bilateral ovarian tumours, and no sound part of an ovary can be found and left (Kelly).

6. When the patient is suffering from osteo-malacia (Herman). The removal of the ovaries has been found to have a curative effect on this disease. In the two latter conditions the uterus is removed, as it is no longer of use to the patient after the ovaries have been taken away.

7. When there is cancer of the cervix (Kelly). If this condition is found to exist, and hysterectomy is decided on, the whole uterus must be removed.

ECTOPIC GESTATION.

From the point of view of treatment cases of extra-uterine gestation are best considered under three headings : (1) Before rupture has taken place; (2) at the time of rupture; (3) after rupture.

1. Cases in which the Tube is Unruptured.

As rupture of the tube almost invariably occurs before the tenth week, this class may be held to include cases of extra-uterine gestation up to two and a-half months. If there is any suspicion that a tubal pregnancy exists, the patient should submit to operation at once. Delay means the risk of rupture and severe or fatal hæmorrhage. The operation is practically identical with that described for removal of the appendages. Adhesions are recent, and do not give rise to much trouble. Care must be taken not to rupture the sac in the separation of adhesions or in drawing it up into the wound for the purpose of ligaturing the broad ligament. Should severe hæmorrhage from this cause occur, it should be controlled by quickly applying the ligatures to the pedicle, or by controlling the blood-supply at the uterine cornu and the brim of the pelvis.

2. At the time of Rupture.

The condition most often calling for operative measures is the result of rupture of the tube, or abortion. Rupture may take place either into the peritonæal cavity or between the layers of the broad ligament. It more often happens, however, that hæmorrhage from the tube is preceded by the formation of a mole, which the tube attempts to expel, though generally without success, from the abdominal ostium. This event is known as tubal abortion. Though likely to be continuous or frequently repeated, the bleeding is much more moderate in amount as a rule than that following a rupture, which is often profuse and attended with grave danger to life.

Should an operation be performed in all cases in which this accident is diagnosed? We know that many cases get well if left alone, though what proportion they bear to those requiring operation we cannot at present say. A patient occasionally dies of hæmorrhage before assistance can be obtained, whilst in many instances, on the other hand, the

initial symptoms are so slight that the patient pays but little attention to them, and it is only on account of a persistence or a recurrence of pain that a surgeon is called in, perhaps weeks after the onset. When the symptoms are so grave that life is threatened, there can be no doubt as to the advisability of immediate operation. But if the patient is recovering when first seen, and the collapse and signs of hæmorrhage are not severe, the indications are less clear. There is no doubt that in many cases no ill results will follow from delay for a time. But though the initial bleeding is slight, it may recur later with greater severity, and the danger of temporising in any recent case should consequently be fully recognised. In addition to the risk of recurrent hæmorrhage which may prove fatal, there are other points to be borne in mind. The fœtus may have survived the initial accident, and an operation performed later in pregnancy, on this account, will be attended with greatly increased risk. Bleeding may continue or recur until a large mass is formed sufficient to press on the bowel and cause symptoms of obstruction. Or the hæmatocele resulting may fail to absorb or may suppurate. I have seen a round solid clot, the size of a cricket ball, lying loose in the pelvis a year after bleeding had occurred. Even if absorption does take place, it will be followed probably by occlusion of the tubes and the formation of adhesions. When rupture or abortion has occurred recently, operation is easy. There are no adhesions or such only as can be dealt with readily. On these grounds it would appear to be safer to operate in all cases in which a recent rupture or abortion has been diagnosed, abdominal section being performed and the tube removed. Putting on one side those cases in which an operation is immediately demanded on account of profuse hæmorrhage, the mortality of the operation is very small. Convalescence after removal of the tube and blood-clot is, moreover, much shorter than in those cases where we wait for the absorption of the hæmatocele. If a diagnosis of rupture into a broad ligament can be made, it is perfectly justifiable to wait awhile, as the hæmorrhage will, in all probability, soon cease, and the hæmatocele can, if necessity arises, be dealt with later by drainage.

The Operation.—An incision, four to five inches long, is made in the median line and carried well down to the pubes. If the case is a severe one, blood may at once escape from the abdomen when the peritonæum is opened. This is mopped and scooped out as rapidly as possible, and if it appears that hæmorrhage is continuing, no attempt should be made to cleanse the peritonæal sac, but the bleeding controlled at once. This is done by identifying the fundus and tracing the affected tube outwards from this. The sac is drawn up towards the wound, and a pair of Spencer Wells's forceps are applied to the uterine end of the tube, so as to include in its grasp the terminal branches of the uterine artery, and a second pair to the broad ligament at the brim of the pelvis to secure the ovarian artery. The abdomen can then be cleansed by means of sponges or by washing out with warm water, and the parts inspected. The tube is then brought up into the wound and ligatures applied, as described in the section on the removal of the appendages.

3. After rupture of Sac.

Under this heading may be included those cases which are seen some

time after rupture or abortion has occurred. Treatment then resolves itself into dealing with a collection of blood in the pelvis, either shut off by adhesions and matted viscera from the general peritonæal cavity, or lying between the layers of the broad ligament.

If on account of recurrent attacks of pain and marked anæmia there is reason to suspect repeated hæmorrhages, abdominal section should be performed and the tube removed. This will differ from the operation undertaken at the time of rupture in that the tube and blood-clot will be found enclosed by adhesions and matted bowel and omentum. These latter must be carefully separated until the sac and surrounding blood-clot are brought into view. The tube is then dealt with as previously described. If some time has elapsed since the accident and the hæmatocele, more especially if it is a small one, shows signs of undergoing absorption, the case may be treated by rest, in the hope that the swelling will subside.

If there are no signs of fresh bleeding, and the hæmatocele, which is bulging down Douglas's pouch, shows little tendency to diminish in size as the result of rest, it should be treated by drainage through the vagina. This operation should not be performed within the first two weeks following the rupture, or when evidence exists that bleeding is continuing. Violent hæmorrhage may be set up on opening the sac, and a fatal result has been known to follow. It would be better under these circumstances to open the abdomen, clear out the blood clot and remove the tube. When rupture has taken place into the broad ligament, Dr. Kelly (*loc. supra cit.*, vol. ii. p. 456) considers that the proper treatment is to evacuate and drain the sac extra-peritonæally, either by the vagina or above Poupart's ligament. It should be opened in the latter situation when "the sac elevates the peritonæum of the anterior abdominal wall, so as to be easily accessible from the front." In most cases, however, blood poured out in this situation is moderate in amount and undergoes absorption. Unless, therefore, the swelling is a large one or it is undergoing suppuration, a rare accident, it may be left alone.

If the foetus survives the patient runs the risk of a secondary rupture, and as pregnancy advances operation is attended with increasing danger. It is said by Pinard to be no greater at full time than it is during and after the fifth month. During the first four months of gestation there is no doubt about the advisability of immediate operation, and the removal of sac, foetus and placenta may be attempted. After this time the increase in size of the placenta calls for a different line of treatment. The best time to operate is not yet agreed upon, but a strong point in favour of interference as soon as the condition is recognised is the risk of secondary rupture. Operations undertaken after the death of the foetus at full term are attended by less danger of hæmorrhage, owing to the shrinkage of the placental vessels. In any case that is diagnosed towards the end of pregnancy it would, in consequence, be sound treatment to defer the operation for some weeks after full term. Though the risk of death from hæmorrhage is thereby greatly diminished, this delay is attended by the possibility of putrefactive changes taking place in the placenta. As the child will most probably be weakly and is often malformed, any measures undertaken should be in the interest of the mother rather than of the child. The

question of operating at full term for the sake of saving the child is consequently not one that should carry much weight.

An incision should be made in the median line, and low down to begin with between the symphysis and umbilicus to avoid the possibility of injury to a placenta seated in the upper part of the sac (Jellett, *Manual of Midwifery*, 1905, p. 672). The difficulties of removal of the sac are so great and so fraught with danger, that the safest plan of dealing with it is to suture its edges to the abdominal incision. Where possible the peritonæal cavity should not be opened. The greatest difficulty that the surgeon has to contend with is the placenta. If some weeks have elapsed since full term it can be removed as a rule without difficulty. It can also be detached in some cases in which it is situated in the upper part of the sac. If attached below the foetus, the best plan is to tie the cord close to the placenta without disturbing the latter, and to pack the cavity with iodoform gauze. At the end of a fortnight to three weeks an attempt is made to remove the placenta, the packing of the sac being continued till it is obliterated. The great risk of this procedure is septic infection before the placenta can be removed. Another plan is to close the abdominal wound leaving the placenta *in situ*, trusting to atrophy and absorption of the latter taking place. Owing to the close proximity of the bowel, infection is a not unlikely contingent, and the wound may have to be re-opened on account of suppuration.

CHAPTER XIX.

SACRO-ILIAC DISEASE.

ARTHRECTOMY.

It has been shown that the prognosis in this disease, usually looked upon as so grave, is much better if the same radical methods of treatment, which have proved so satisfactory in other joints, are applied to the sacro-iliac synchondrosis.

Mr. Collier first drew attention to the above fact with a case successfully treated by trephining (*Lancet*, 1889, vol. ii. p. 787), and Mr. Makins and Mr. Golding Bird followed, each surgeon publishing three successful cases (*Clin. Soc. Trans.*, vol. xxvi. p. 127, and vol. xxviii. p. 186). The following points are taken from these papers:

Operation.—The joint is exposed by a crucial incision (Makins), or by a flap (Collier, Golding Bird). In the words of the last-named surgeon, “a semicircular flap of skin and subcutaneous tissue over the iliac area of the joint, and having its convexity corresponding to the posterior edge of the ilium, is dissected upwards and forwards, and the underlying glutæi are detached. The bone being thus freely exposed, a large trephine is applied at the root of the posterior inferior iliac spine, and in a line drawn from the top of that spine to the junction of the anterior with the middle third of the iliac crest. . . . The ilium at the seat of operation is very thick, but the disc of bone removed should reach quite down to the joint.” The trephine-opening is then sufficiently enlarged, the articular surfaces cut away with a gouge or forceps sufficiently to enable the surgeon to explore the pelvic surface of the joint, and to liberate any pus lying on this aspect. The sharp spoon, or Barker’s flushing gouge, is then thoroughly used, all fragments of bone, granulation tissue, or loosened cartilage removed, and any sinuses present laid open. Sterilised iodoform having been next applied, the soft parts are lightly drawn together with a few sutures. A long outside, or a Thomas’s hip-splint, should be used at first, but subsequently all that is needed is a well-fitting pelvic belt, as advised by Mr. Hilton.

PART V.

OPERATIONS ON THE LOWER EXTREMITY.

CHAPTER I.

OPERATIONS ON THE HIP-JOINT.

AMPUTATION AT THE HIP-JOINT. EXCISION OF THE HIP-JOINT. OPERATIVE TREATMENT OF HIP-DISEASE. INCISION OF THE JOINT.

AMPUTATION AT THE HIP-JOINT (Figs. 360-369).

THE numerous methods which have been described are easily simplified. The indications for this operation are tuberculous disease, and, occasionally, osteo-myelitis, growths, and injury. For tuberculous and other infective disease the method of Furneaux Jordan, performed in two stages as advised by Sir H. Howse, for growths or injury either the methods of Wyeth or Lynn Thomas, or, where these are not available, some modification of lateral skin-flaps, and division of the muscles high up should be adopted. While a few others will be described, the above will suffice for all practical purposes.

Methods.—I. Furneaux Jordan's, performed in two stages (Sir H. Howse). II. Lateral Flaps. III. Modified Lateral—viz., Antero-internal and Postero-external—Flaps. IV. Antero-posterior Flaps.

Methods of Controlling Hæmorrhage during Amputation at the Hip-Joint.

1. *Elastic Compression by Jordan Lloyd's Method* (Fig. 363).—This may be applied at the junction of the limb and trunk, without interfering with the operator, by the following method: While the patient is passing under the anæsthetic, the limb is emptied of blood by elevation and application of Esmarch's bandages as far up as the tissues are healthy; the patient is then rolled over on to his sound side, and a piece of rubber bandage about two yards long, and stout enough to require decided exertion to stretch it fully, is doubled and passed between the thigh and trunk, its centre lying between the anus and tuber ischii over a narrow pad of gauze. A sterilised white roller bandage, of appropriate size, is then laid over the termination of the external iliac artery. The ends of the rubber bandage are now

to be firmly and steadily drawn in a direction upwards and outwards, one in front of the groin and one over the buttock, to a point above the centre of the iliac crest, sufficient tightness being employed to stop all pulsation in the femorals or tibials. The front part of the band passing over the white bandage occludes the external iliac and runs parallel to and above Poupart's ligament. The posterior part runs across the great sacro-sciatic notch and controls the branches of the internal iliac. If the surgeon is short-handed, instead of the cords being held by an assistant, they may, by means of tapes strongly stitched to them, be thus secured: having been drawn with full tightness up to the centre of the iliac crest, they may be crossed over to the opposite side and tied firmly (over lint) midway between the crest and the top of the great trochanter. If a strong and trusty assistant is forthcoming, it will be better to leave the bandage in his hands, but in the case of an adult whose tissues are not wasted, and on a hot day, the exertion is not a slight one.*

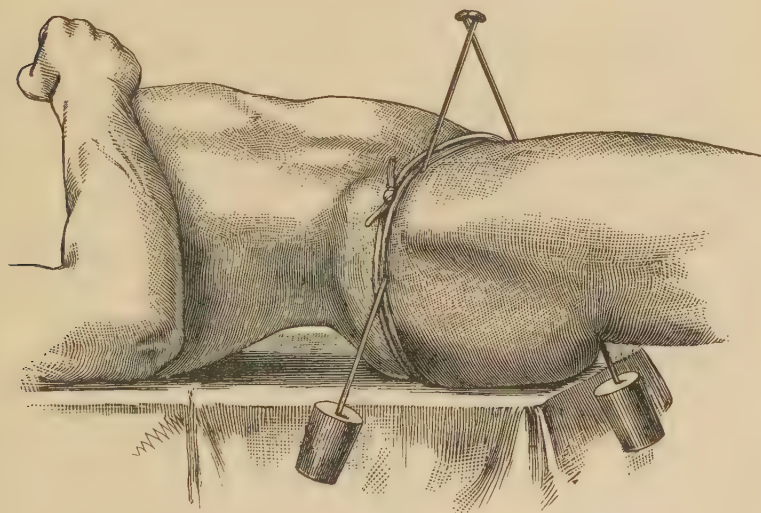
Whether the bandage be held or tied, especial care must be taken that it does not slip from off the external iliac nor over the tuber ischii. It is a good plan to pass the ends of the india-rubber band over a slip of wood, so as to diminish the prolonged pressure on the hands. To prevent the bands slipping down in the way of the surgeon, two loops of tape or bandage may be thus employed: each, about two feet in length, is placed longitudinally, before the elastic band is applied, the one over the groin, the other well behind the great trochanter, the centre of each being where the elastic band will go. When the band has been applied, these form loops by means of which the band is kept well out of the operator's way, both at Poupart's ligament and behind the great trochanter (Jordan Lloyd, *Lancet*, 1883, vol. i. p. 897).

2. *Wyeth's Bloodless Method of Amputation at the Hip-Joint*.—I have mentioned this in the account of amputation at the shoulder-joint at p. 181, Vol. I. It has been largely used by American surgeons, and has given excellent results. Amongst these Dr. Hancock, of Georgia, records (*Ann. of Surg.*, July 1906, p. 98) a successful amputation at the hip-joint, and one at the shoulder and hip-joints, for railway accidents. Primary shock was absent in each case to a very unusual degree. The pins must be passed with exactness, and, unless of sufficient strength, will certainly bend under the strain of the cord above. Their use is thus described (*Ann. of Surg.*, 1897, vol. i. p. 132): "The limb to be amputated should be emptied of blood by elevation of the foot, and by the application of the Esmarch bandage, commencing at the toes. Under certain conditions, the bandage can be only partially applied. When a growth exists, or when septic infiltration is present, pressure should be exercised only to within five inches of the diseased portion, for fear of driving diseased material into the vessels. After injuries with great destruction, crushing or pulpefaction, one must generally trust to elevation, as the Esmarch bandage cannot always be

* As will be seen from the description of the operation below, this exertion is only required during shelling out of the femur, a step often simplified by a previous excision. During the circular amputation in the lower third of the thigh, and the securing the large vessels here, there is abundant room to control these at first by an Esmarch's bandage applied over sterile gauze. The parts should be resterilised.

applied. While the member is elevated, and before the Esmarch bandage is removed, the rubber-tubing constrictor is applied. The object of this constriction is the occlusion of every vessel above the level of the hip-joint, permitting the disarticulation to be completed, and the vessels secured without hæmorrhage and before the tourniquet is removed. To prevent any possibility of the tourniquet slipping, I employ two large steel needles or skewers, three-sixteenths of an inch in diameter and ten inches long, one of which is introduced one-fourth of an inch below the anterior superior spine of the ilium and slightly to the inner side of this prominence, and is made to traverse superficially for about three inches the muscles and fascia on the outer side of the hip, emerging on a level with the point of entrance (Fig. 360). The point of the second needle is thrust through the skin and tendon

FIG. 360.



Wyeth's bloodless method of amputation at the hip-joint.

of origin of the adductor longus muscle half an inch below the crotch, the point emerging an inch below the tuber ischii. The points should be shielded at once with cork to prevent injury to the hands of the operator. No vessels are endangered by these skewers. A mat or compress of sterile gauze, about two inches thick and four inches square, is laid over the femoral artery and vein as they cross the brim of the pelvis; over this a piece of strong white rubber tubing, half an inch in diameter when unstretched, and long enough when in position to go five or six times around the thigh, is now wound very tightly around and above the fixation-needles and tied. Except the small quantity of blood between the limit of the Esmarch bandage and the constricting tube, the extremity is bloodless and will remain so."

The Esmarch's bandage is now removed and a circular incision is made six inches below the tourniquet joined by a longitudinal incision commencing at the tourniquet and passing over the trochanter major. A cuff including the subcutaneous tissue down to the deep fascia is

dissected off to the level of the trochanter minor. About this level the remaining soft parts are divided down to the bone with a circular cut and are rapidly dissected from the femur. The vessels should now be searched for and both arteries and veins securely tied. It is advisable to tie all the vessels that can be seen at this stage, *i.e.*, before disarticulation, to prevent their retraction. The muscular attachments are separated so that the capsular ligament may be exposed and divided. The limb being used as a lever, the thigh is forcibly elevated, abducted, and adducted, letting in air and rupturing the ligamentum teres.*

FIG. 361.



Lynn Thomas's forceps-tourniquet.†

The tourniquet may now be carefully loosened and all bleeding points at once seized. In cases of great exhaustion Dr. Wyeth would do the operation in two stages, securing the vessels, dividing the femur below the lesser trochanter, closing the wound and turning out the head of the femur about two weeks later. While the 633 cases of amputation at the hip-joint collected by Ashurst showed a mortality of 64.1 per cent., of 69 cases performed in this manner only 11 died—a mortality of 15.9.

3. Forceps-tourniquet of Lynn Thomas (Figs. 361 and 362).† An account of this instrument, with its advantages, will be found in the *Lancet*, April 23rd, 1898, *Brit. Med. Journ.*, April 20, 1901, and Oct. 1, 1904. Fig. 362 shows the method of applying the forceps in disarticulation at the hip, or in any amputation of the lower extremity. A small skin incision is made in the front of the thigh, one to three inches below the anterior superior spine according to the size of the limb. The smooth probe-pointed blade is pushed forcibly through the skin incision well down towards the neck of the femur, and in a transverse direction towards the spine of the pubes, the serrated blade of the forceps being outside, and when the tourniquet is driven well beyond the line of the common femoral vessels, it is clamped like an ordinary catch-forceps. Mr. Griffiths, of Cardiff, gives the following additional details as to the employment of this instrument in

a successful case of amputation at the hip-joint for a periosteal sarcoma (*Brit. Med. Journ.*, Dec. 19, 1903, p. 1583). The vertical limb of a racket-shaped incision was commenced about two inches above the great trochanter, and into this incision, at its upper part, was inserted the smooth blade of Lynn-Thomas's tourniquet forceps. This having been pushed on in the direction described above, and the forceps clamped, the

* Where in cases of disease, the femur gives way high up, or where it is extensively crushed, the required traction and leverage will be afforded by tying a piece of sterile gauze round the neck (Hancock, *loc. supra cit.*), if no appropriate forceps are at hand.

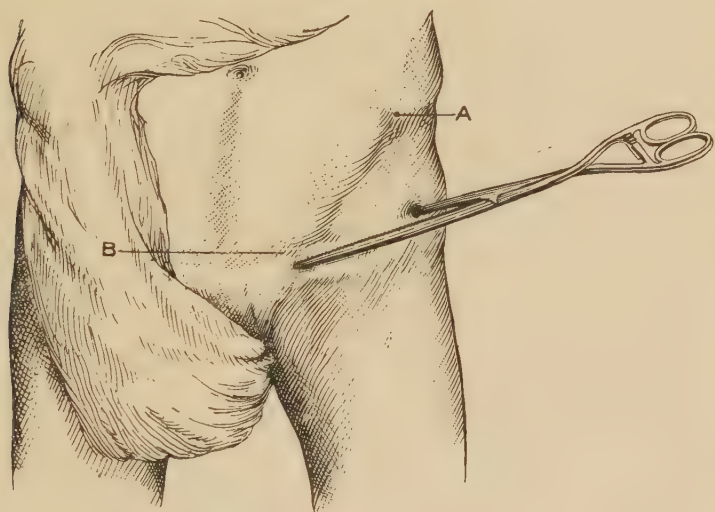
† The use of this instrument is also figured under the account of Syme's amputation.

‡ The most recent form of his forceps-tourniquet, and the method of carrying it in field-service are figured by Mr. Lynn Thomas (*Brit. Med. Journ.*, Oct. 1, 1904).

vessels in the anterior flap were secured. To control the circulation in the posterior flap, another pair of forceps were used, the deep blade passing this time behind the neck of the femur. The oval part of the incision was next marked out, and the skin retracted a little way all round. The muscles attached to the great trochanter and in front of the hip-joint were now divided, the joint opened, and the limb disarticulated, the only spouting vessel seen at this stage being a tiny artery in the capsule. All the vessels which could be seen were next picked up and tied, and then the value of the tourniquet-forceps was demonstrated in the search for the smaller vessels, which were found by loosening the forceps and immediately closing them when a bleeding point shewed the position of a vessel.

Mr. Lynn Thomas gives the following additional proofs of the sim-

FIG. 362.



The forceps-tourniquet applied for amputation of the hip-joint. A, Anterior superior spine of ilium. B, Spine of pubes.

plicity and efficiency of his instrument. In a case which was believed to be one of central sarcoma of the lower end of the femur, he had amputated through the lower third of the thigh, controlling the hæmorrhage by the method given above. As after the ligature of all visible blood vessels and loosening the forceps, unusually free oozing took place along the linea aspera, close inspection showed that the growth had extended here. The forceps were reclamped in a second, and after the upper limit of the growth had been defined, the limb was amputated in the upper third of the thigh. Primary union followed. "Though the tourniquet compressed the common femoral vessels and the accompanying nerves for fifty minutes, the only evidence of vaso-motor paresis was confined absolutely to the skin under the outer blade of the forceps-tourniquet."

The following are amongst the cases in which the forceps-tourniquet has been successfully used by Mr. Lynn Thomas (*Brit. Med. Journ.*, Oct. 1, 1904). Three amputations through the hip-joint, with three

recoveries; three interscapulo-thoracic amputations with three recoveries. The application of the instrument in this operation is well shown. One arterio-venous aneurysm in Hunter's canal, which recovered. Here Mr. Lynn Thomas used two pairs, one to control the vessels at the upper end of the skin incision, and the other at the lower end. "In this operation I made the skin incision down to the fascia lata, but not injuring it, as it formed the outer barrier to the traumatic aneurysm; the probe-shaped blade was pushed boldly through in the direction of the inner aspect of the femur, and driven in as far as it would go, and then clamped (the flat blade being, of course, outside the skin), and the other forceps-tourniquet was applied in a similar manner at the lower border of the skin incision. The fascia lata was then divided and the clots turned out, the partially divided artery and veins were easily found, divided and ligatured. Control of hæmorrhage was as complete as if one had the vessels divided between two ordinary pairs of hæmostatic forceps."

Mr. Lynn Thomas further points out that his instrument will be found especially valuable in injuries to the femoral vessels by gunshot or other wounds, and especially so where the injury lies close to Poupart's ligament, as here prompt treatment is especially called for, and the control of hæmorrhage a matter of much difficulty. Any wound present would, of course, be enlarged, as needed. The following are the advantages of the forceps-tourniquet over other instruments, especially Esmarch's bandage: (1) It is not affected by climate; (2) it is easily sterilised; (3) it is most useful in major operations; (4) it does not require an assistant to look after it; (5) in no case has Mr. Lynn Thomas seen its use followed by that oozing which is so common after the employment of Esmarch's bandage.

4. *Macewen's Method of Compression of the Abdominal Aorta* (*Ann. of Surg.*, 1894, vol. i. p. 1).—Prof Macewen has used the following for many years, and has found it simple, always ready, easily applied and efficient. No injury has followed to the small intestines. If the patient vomits or coughs violently, the pressure must be temporarily increased. As the patient lies on his back on the table, the assistant, facing the patient's feet, stands on a stool at the left side of the table in a line with the umbilicus. He then places his closed right hand upon the abdomen, a little to the left of the middle line, the knuckles of the index finger first touching the upper border of the umbilicus so that the whole shut hand will embrace about three inches of the aorta above its bifurcation. The assistant then standing upon his left foot, his right foot crossing his left, leans upon his right hand, and thereby exercises the necessary amount of pressure. With the index finger resting upon the common femoral at the brim of the pelvis, the assistant can easily estimate the weight necessary for the purpose. In this way an efficient assistant can control the circulation for half an hour without fatigue.

5. *Compressing the Common Femoral or the Termination of the External Iliac* by the fingers or hands, aided, if need be, by a weight. This is only possible in the case of a child, and the assistant thus employed is liable to be in the way of the operator.

6. *Lister's Tourniquet*.—This means of compressing the termination of the abdominal aorta is not a light matter, apart from the very grave operation into which it enters. This is owing to the difficulty of making sure of avoiding such important structures as the

duodenum, pancreas, solar plexus, and small intestines, and to its interference with respiration and circulation. The bowels must be thoroughly emptied beforehand, and got out of the way by gently rolling the patient on to his right side before the pad is applied. In the *Amer. Text-Book of Surg.*, p. 1193, two useful hints are given, one to apply a soft sponge between the pad and the skin, and the other not to lose a moment in putting catch-forceps on the chief bleeding points after the main vessels have been tied, so that the tourniquet may be promptly loosened.

7. *Compression of the Common Iliac through an Abdominal Incision.* (Dr. C. McBurney *Ann. of Surg.*, Aug. 1894, p. 181.)

8. *Ligature of the Common Femoral Artery.*—The incision is utilised afterwards in shaping lateral or some modification of lateral flaps. The surgeon must be prepared for the hæmorrhage from the gluteal and other branches of the internal iliac artery.

9. *Commanding the Main Artery* during the operation by seizing it in the flap (Figs. 367 and 368).

Furneaux Jordan's Method (Fig. 363).—By amputating through the thigh as low down as possible, and shelling out and disarticulating the femur, it is now possible to avoid, in large measure, those dangers which were formerly inseparable from the operation—viz.: 1. Shock, the limb being removed much farther from the trunk. 2. Hæmorrhage. *a.* Abundant room is afforded for compression of the common femoral, and the vessels behind. *b.* The large vessels can easily be secured on the face of the stump, low down. *c.* The gluteal and sciatic arteries remain untouched, the hæmorrhage from these, in the older operations, being a source of serious danger. 3. Infection. By the other methods, the copious discharge of bloody serum from the large wound,* being poured out close to the anus and genitals, was very liable to infection. By this operation, both the end of the stump and the wound on the outer side can be more easily drained and kept aseptic. In making use of this amputation, especially for hip disease or failed excision, the surgeon should not attempt too much to secure primary union. 4. The stump is a better one. It is longer, more mobile, and occasionally, as in amputation for acute periostitis or necrosis, it is possible to preserve much of the periosteum from the upper half of the femur, and a cord† will be left which will render the stump

* While the wound in a Furneaux Jordan amputation is also a large one, it is much more happily placed for drainage.

† The committee of the Clinical Society appointed to examine Mr. Shuter's case of sub-periosteal amputation of the hip-joint reported (*Trans.*, vol. xvi. p. 89), (1) that, though there was a firm, resisting cord of considerable size in the centre, which afforded the muscles a common point of attachment, there was not sufficient evidence to enable them to state that this cord contained bone; (2) that the muscles were in a high state of nutrition, the patient not only powerfully flexing, extending, abducting, and adducting his stump, but being able to communicate all these movements to the artificial limb.

Mr. Shuter in his paper (*loc. supra cit.*) said that his patient was able to wear an artificial limb "for some hours nearly every day for a period of about five months. I then forbade his wearing it for a time on account of a tender sinus which opened opposite to the acetabulum." I have now performed this amputation seven times. Six recovered, and, in one of my three cases in adults, a delicate girl of 22 has been able to wear a very light limb, made by Messrs. S. Maw, Thompson and Sons, for three hours at a time. In such cases as these, where the patient is much reduced by long-standing hip disease, and the periosteum is still adherent to the wasted femur, it is not, in my opinion, advisable to spend time in stripping it off. While the shock of the hip-joint amputation is much lessened by the Furneaux Jordan method, it cannot, of course, be entirely removed.

movable. Whether in any case an artificial limb can be worn for more than a short time is very doubtful.

I. **Furneaux Jordan's Operation** (Fig. 363).^{*}—The modification of Sir H. Howse in two stages is given at p. 884. Every provision must be taken against shock. The limbs should be bandaged in cotton-wool, the body well wrapped up on a hot-water table, the head kept low, ether given, saline infusion employed intravenously or into the cellular tissue, or by both means (vol. i. p. 141). Injection of eucaine into the chief nerve trunks is referred to at vol. i. p. 226, and subcutaneous injections of brandy and strychnine should be given from time to time.

Before commencing the circular amputation, I have the limb elevated, an Esmarch bandage applied up to the knee, the thigh emptied of venous blood by firm stroking, and a second Esmarch bandage then applied firmly just below the trochanters, and the lower one removed. The india-rubber band is also (p. 875) placed, lightly, ready *in situ*. The circular amputation is then performed, and the large vessels secured. The upper bandage is next removed, the region which it occupied resterilised, and the india-rubber band firmly tightened while the femur is shelled out or, perhaps, disarticulated, if the whole operation is performed in one stage.

The patient's pelvis is brought to the edge of the table and the body rolled a little on to the sound side, the surgeon standing usually to the right of the diseased limb—*i.e.*, inside on the left and outside on the right side—draws up the soft parts forcibly with his left hand, and makes a circular incision through the lower third of the thigh, using his knife as at p. 933, the assistant who is in charge of the limb rotating it so as to make the tissues meet the knife. A circular cuff-like flap of skin and fasciæ is then quickly raised for about two inches and a half,[†] an assistant, who stands opposite the surgeon, giving much help here, by seizing and everting the cut edge of the flap as the surgeon raises it. The flap being drawn upwards out of the way, the soft parts are severed by one or two vigorous circular sweeps down to the bone, and the large vessels and any others that can be seen are

^{*} Dr. W. E. Arnold, assistant-surgeon U.S. Navy, has kindly drawn my attention to the fact that an amputation, in all essentials the same as Furneaux Jordan's, was performed as long ago as 1806 by Dr. W. Brashear in Bardstown, Kentucky. The following account taken from a letter by Dr. Brashear will be found in Dr. Mott's edition of Velpeau's *Surgery*, in a summary of hip-joint amputations by Dr. Eve, of Tennessee. The patient was a lad, aged 17. An operation on the thigh in the ordinary manner was determined upon, as remote from the hip-joint as circumstances might justify (in this case, about mid-thigh). The amputation was performed and the arteries secured. The next step was to make an incision to and from the lower end of the bone externally over the great trochanter, to the head of the bone and upper part of the socket. The dissection of the bone from the surrounding muscles was simple and safe, by keeping the edge of the knife resting against it. The bone being disengaged from its integuments at its lower extremity, was then turned out at a right angle from the body, so as to give every facility in the operation to separate the capsular ligament and remove the head from its socket. The patient made a good recovery. Judging from a letter from Prof. Ollier to Mr. Shuter (*loc. supra cit.*) the former surgeon had recommended this method in 1859, and performed such an operation once.

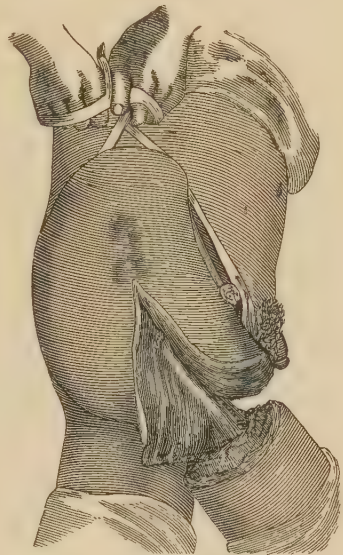
[†] The surgeon need not trouble to raise a larger circular flap: As the femur is removed, the muscles lose their fixed point to contract from, and are thus easily covered.

next secured. Pressure* is now made with sterilised pads on the still oozing wound, the upper india-rubber bandage (p. 876) is tightened, and the patient being rolled well over on to his sound side, the surgeon cuts along the outer side of the thigh, starting from the circular wound and ending about midway between the iliac crest and top of the great trochanter. This incision goes straight down to the bone and runs into any excision wound, or sinuses which may exist over the joint. The soft parts are then rapidly stripped off the femur, partly with the knife, partly with the finger, the only difficulty met with being along the *linea aspera*. If an excision has been performed, the operation is rapidly completed, but if the head and neck remain intact, the final steps will be rendered more difficult, and the joint must be opened from the outside by cutting strongly on the neck of the bone, this being facilitated by the assistant moving the limb, in accordance with the surgeon's directions, as different parts require to be put on the stretch, strong outward rotation of the femur and dragging of the head away from the acetabulum being required at the last.

Free drainage must be provided, for it must be remembered that the wound left by this method is a very large one, though it has the advantage of being farther removed from sources of infection. Thus, especially if the tissues are riddled with sinuses, too much of the wound must not be closed, and, if shock is present, the surgeon must not wait to insert many sutures, but, trusting to firm bandages over an aseptic dressing, get his patient quickly back to bed. If disease of the acetabulum be present the surgeon will, if the patient's condition admit of it, attend to this, the use of a sharp spoon (Fig. 371) and the insertion of a drainage-tube through this bone being specially required if pelvic suppuration be present.

In some cases shock is marked from the very beginning of the operation. This was most markedly the case in one of the patients mentioned in the footnote, p. 881, a very delicate young lady of 22. It was only by not waiting to do more than secure the femoral, making firm sponge-pressure on the flaps, tilting up the end of the table so as to keep the head low, inserting no sutures, but trusting only to firm bandaging over dry gauze dressings, that a fatal result was averted.

FIG. 363.



Furneaux Jordan's amputation. Above is shown the means of controlling hæmorrhage described at p. 875. Lower down are seen the sinuses of an unhealed excision, and the method of shelling out of the femur, after a circular amputation has been performed, and the large vessels secured.

* Valuable time should not be wasted in trying to secure every bleeding point either now or later.

Sir H. Howse's Two-stage Modification of the Above.—As in spite of its advantages the Furneaux Jordan method must always be accompanied by shock, and as in spite of strenuous use of elastic compression the loss of blood, especially in adults, may be too much for the patients where their usual exhausted vitality is remembered, I strongly advise my readers to follow Sir H. Howse, and to remove the limb in two stages whenever this is possible, as in cases of tuberculous disease. My own experience is based upon four cases, in which I superintended its performance by my house-surgeons. Two of the patients were in a most unfavourable condition: all recovered. The limb is first removed by a circular amputation through the lower third of the thigh, and, about a fortnight later, the rest of the femur is taken away. By the adoption of this course, the shock is greatly diminished. The blood which would have been circulating in the rest of the limb is returned into the trunk before the first operation. By the removal of the limb the length of leverage which exerts a disturbing influence on the diseased joint and the need of a splint are done away with. The patient rapidly recovers lost ground, and is, at the close of the second operation, in a much better condition for the curetting of sinuses, now usually needful. These advantages, in my experience, outweigh the disadvantage of two operations, and the double anæsthetic.

Amputation by Different Flap Methods.—The following will be given here, it being understood that in no case can any of them be recommended if the above method is available. In all, shock should be diminished by the injection of eucaine into the chief nerve trunks preliminary to their division, by the method of Crile and Cushing (vol. i. p. 226). Whenever available, the method of Lynn Thomas or Wyeth for arresting hæmorrhage (pp. 878 and 876) should always be employed.

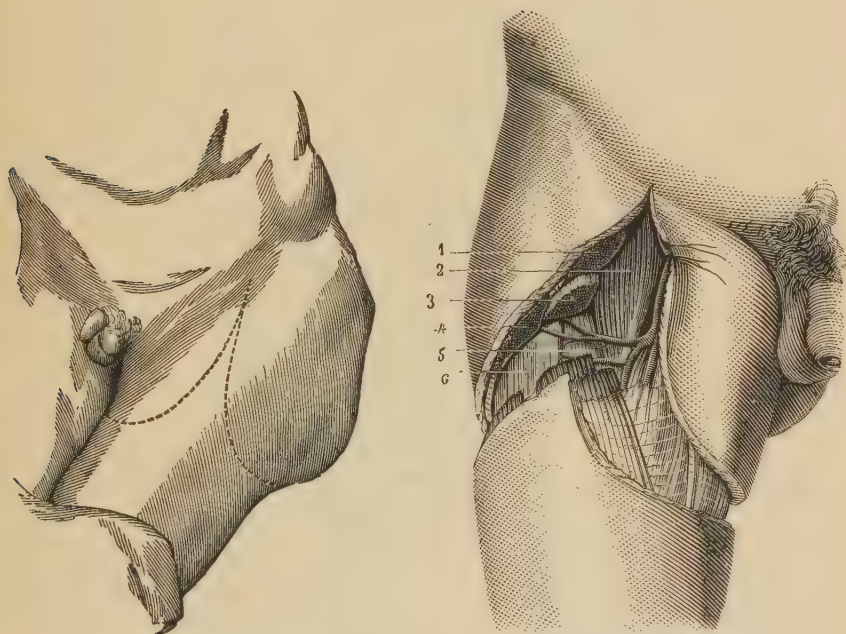
II. Lateral Flaps.—The methods of Larry and Lisfranc need not be more than alluded to here. In both, the flaps were cut by transfixion, and were about four inches long. Larry tied the common femoral as a preliminary step. Flaps made by either method are so bulky as not to be recommended.

If the surgeon wishes to use lateral flaps, as in a case involved by growth in front, he may make them, thus, from without inwards: Standing on the right side of either limb, he, *e.g.*, in the case of the right limb, marks out an inner flap by means of an incision starting from below the tuber ischii, carried downwards along the inner aspect of the thigh for about four inches and then curving upwards to the centre of the groin and ending a little below Poupart's ligament, to the outer side of the femoral vessels; next, without taking off his knife, he marks out an outer flap by cutting between the same points, but in the reversed direction. This incision, as it passes downwards, outwards, and backwards, should leave the front of the limb about a hand's-breadth below the great trochanter. The flaps having been dissected up, the soft parts are cut through from without inwards, the femoral vessels being secured before they are cut, and disarticulation performed last.

III. Antero-internal and Postero-external Flaps (Figs. 364, 365).—This is a modification of the last method, and will be useful in cases of growth extending high up, where it is impossible to perform a Furneaux Jordan's amputation. Some such flaps as the above may be the only ones obtainable. They may be made as follows: The precautions as to shock given at p. 882 having been taken, hæmorrhage will be best met by the details given at p. 878, if Mr. Lynn Thomas's

forceps-tourniquet is available. The patient's pelvis is then brought well down to the edge of the table, and the opposite limb being held aside but not tied, the surgeon, standing to the right of either limb, reaches somewhat over and marks out (in the case of the right limb) an antero-internal flap, but cutting from a point close to the tuber ischii to one a little below and internal to the anterior superior iliac spine. The skin and fasciæ having been dissected up, the muscles are cut through till the femoral vessels are reached and secured. Sterilised gauze is now packed into this wound, and, the patient having been rolled a little

FIG. 364.



Amputation at the hip-joint by modified lateral flaps (anterior racquet-shaped incision). 1, The sartorius. 2, The ilio-psoas. 3, The rectus. 4, The tensor vaginæ femoris. These have been cut and retractors have exposed (5 and 6) the internal and external vasti. A double ligature has been placed upon the common femoral vessels. (Farabeuf.)

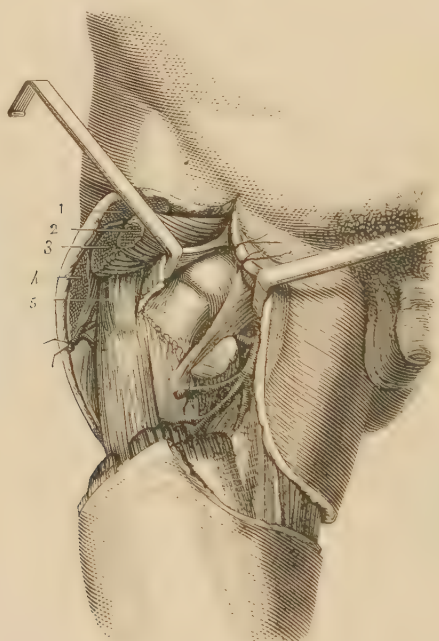
over, a postero-external flap is marked out and dissected up from the glutæal region, passing between the above points, but in the reverse order. The glutæal vessels are next cut through, the chief vessels being secured by Spencer Wells's forceps; the capsule is then opened (p. 886), the round ligament severed, and the limb removed.

IV. Antero-posterior Flaps (Figs. 366—369). Methods of Guthrie and Liston.

—The patient having been prepared against shock (p. 882), and the main vessels secured by one of the methods already given, the limb being brought over the table and supported in the semi-flexed position by an assistant, while the opposite limb is secured over the table by a bandage, the surgeon, standing outside the left and inside the right limb, raising the tissues in front of Scarpa's triangle with his left hand, enters his knife (*e.g.*, on the left side) midway between the anterior superior spine and the top of the great

trochanter, and sends it across the limb so that it emerges close to the tuberosity of the ischium. In traversing the limb the knife should pass as close to the capsule as possible, so as (1) to get behind the large vessels, and (2) to facilitate the opening of the capsule later on. As the knife emerges the surgeon will, of course, be careful of the scrotum and the opposite thigh, and at this moment the point should be well depressed, so as to include all the tissues possible in the anterior flap. With a rapid sawing movement a broad flap is cut, five inches long, an assistant thrusting his fingers into the wound as it is made, and following the back of the knife, to secure the large vessels (Fig. 367, 368). As he then draws up the anterior flap the capsule is exposed, covered with more or less of soft parts, according to the skill with which the knife has been first inserted; the assistant in charge of the limb at this moment extending, depressing, and rotating

FIG. 365.



The same operation as in the last figure, in a more advanced stage. The capsule has been opened and its outer lip drawn aside by a retractor. The other retractor draws inwards and protects the vessels. 1, Sartorius. 2, Psoas. 3, Rectus. 4, Tensor vaginæ femoris. 5, Attachment of gluteus minimus. (Farabeuf.)

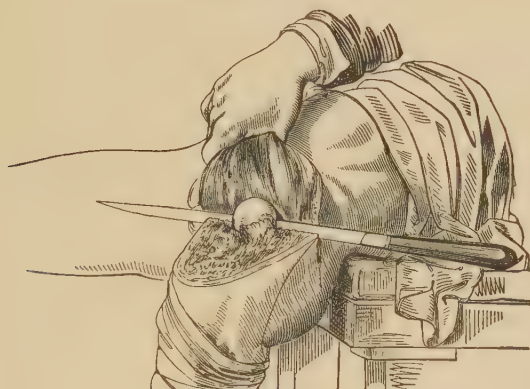
out the femur, so as to put the capsule on the stretch, the surgeon forcibly draws the knife across the capsule, opens it freely, and divides the ligamentum teres (Fig. 369).

The limb being now slightly flexed, adducted, and pulled away from the body, the surgeon severs the parts attached to the great trochanter and the outer aspect of the limb, and, passing his knife behind the bone, cuts a posterior flap about four inches long. The assistant in charge of the limb will facilitate this step, and further the dislocation of the femur, if he bring the thigh upwards and forwards with one hand placed at the back. A large sterilised pad is at once pressed against the posterior flap while the femoral vessels * are secured, or, if these are well in hand, those in the hinder flap are taken first.

* Of these the femoral lies superficially, the profunda more deeply, in the anterior flap; they are shown much too close to each other in Fig. 368.

The glutæal will be found in the glutæal muscles, the sciatic with the nerve nearer the posterior margin of the flap, and the circumflex and obturator closer to the acetabulum. If the patient's condition admits of it, any sinuses are now laid open or scraped out, the acetabulum examined, and, if perforated, drained. If the amputation has been

FIG. 366.



(Fergusson.)*

performed for a growth, any outlying masses are looked for and removed. Any nerves or muscles which need it are now trimmed short, a large drainage-tube inserted, and the flaps carefully united.†

Advantages of this method: Chief of these is its rapidity.—*Disadvantages*: 1. The

FIG. 367.

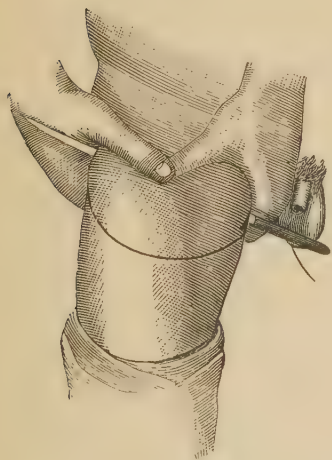
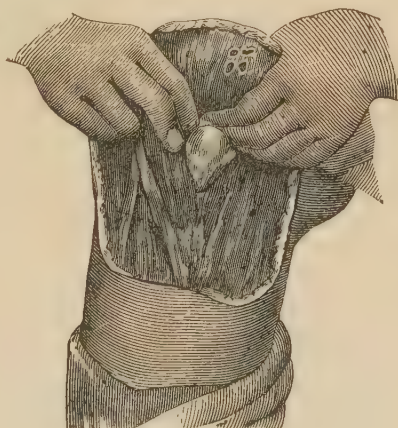


FIG. 368.



hæmorrhage which takes place from the vessels from the posterior flap may be considerable. 2. The large amount of sero-sanguineous oozing which takes place from so many large

* The knife represented here is needlessly long.

† If grave shock is present, the head should be lowered and sutures put in, but not now tied, any oozing being stopped by firm spica-bandaging, and Spencer Wells's forceps left *in situ*. The lower end of the bed should be kept raised, and brandy given subcutaneously and per rectum. Infusion should also be employed early (p. 882, and vol. i. p. 141).

muscles cut obliquely. 3. The fact that, in an adult, it requires a special, long knife, not always found in an ordinary collection of instruments. *Difficulties*: 1. Not passing the knife deeply enough, and thus not exposing the capsule. 2. Passing the knife too deeply, and hitching its point on the bone. 3. Getting the knife stopped in passing it behind the head of the femur. 4. Fracture of the femur.

Guthrie's Method by Antero-posterior Flaps.—Antero-posterior flaps are again made use of, but here they are made from without inwards, and thus can easily be rendered less bulky. A small knife—*i.e.*, one four inches long—suffices.

The preparatory steps being taken as before, the surgeon, standing on the right side of either limb, marks out his anterior flap, about five inches long, by an incision, starting (on the left limb) from just above the great trochanter, passing across the thigh with a broadly curved convexity, and ending just below the tuber ischii. A posterior flap is then marked out by carrying the knife in a similar manner across the back of the limb between the same points, the limb being raised and the surgeon stooping somewhat. This flap should be about two-thirds the length of the first. Both consist of skin and fasciæ. The flaps being held out of the way, the muscles, first on the front and then on the back, are

FIG. 369.



next cut obliquely from below upwards, the femoral vessels, both superficial and deep, being secured as soon as they are exposed, and before they are cut, either by underrunning them with an aneurysm-needle loaded with silk, or by dividing them between two pairs of forceps. The capsule being exposed, disarticulation is performed as before.

EXCISION OF THE HIP. OPERATIVE TREATMENT OF HIP-JOINT DISEASE. INCISION OF THE JOINT.

Indications.—A. Disease, chiefly tuberculous. B. Injury, especially gunshot.

A. Disease.—Few will deny that the progress in the treatment of hip disease has not made, of late years, advances in accordance with the advantages of modern surgery, and the progress made in operations on other parts of the body. While the immediate mortality after operative interference here has been lessened, the results as to real cures are still little creditable to surgeons. The explanation of this fact lies chiefly in the length of time required for a cure of hip-joint disease without operation, from one to two years being no exaggerated estimate of the time for which these cases require to be kept under skilled observation,

and the first six to nine months of this being an average period in which the patient requires to be kept recumbent, even when, what is rarely the case, such treatment is enforced continuously from the first. The difficulty of finding the needful accommodation in general hospitals, and, it must be added, the lack of interest in these cases, when, after the first few weeks, the disease is rendered quiescent, and the process of repair begins; the difficulty of finding teaching material in patients efficiently treated by fixed apparatus, the frequent change in the personnel of our medical schools, and the preference for cases of more decided interest and involving operations with more speedy results; all these facts admit of no denial.

With reference to operative interference, the advocates of earlier excision have much reason in their claims. While, theoretically, the disease can be cured by sufficient efficient rest, in practice such rest is rarely secured. Tuberculous disease here runs the same course as elsewhere, and early complete removal, care being taken that the first operation is so complete as to be the last, is acknowledged to be the best way of dealing with tubercle.

Certain points, however, connected with the hip-joint prevent the results of such advocacy being as successful here as elsewhere. In cases where excision is performed early, before suppuration is a marked feature, complete extirpation of the synovial membrane, especially its posterior portion, often not an easy matter in the case of the knee-joint, is rendered far more difficult here, thus explaining the reappearance of the disease. And when this difficulty has been overcome and rapid healing of the wound has been secured, the patient, if examined later, is often found to have an unsatisfactory flail-like, unstable limb, liable to flexion and other deformities. With regard to this second objection to early excision of the hip-joint, it may be admitted that it would be partly met by more prolonged efficient rest. The difficulties of securing this have already been alluded to.

When excision is performed later and abscesses are present, satisfactory dealing with these is usually rendered extremely difficult by their devious tracks, the risk of leaving a tuberculous sinus, and of this becoming, later, the seat of mixed infection. Then follow one or more curettings, and the child is sent out in a Thomas's splint, or perhaps to a convalescent home, or otherwise lost sight of; the dislike to having even mild cases of suppuration in the wards of a general hospital playing a large part in the interruption in the treatment.

The truth is that the only satisfactory treatment of hip-joint disease is the preventive one by strict adequately prolonged rest. This will not be obtained while these cases are treated in general hospitals. Institutions on a large scale, especially adapted to this class of case, are what is needed.

The unsatisfactory results met with after excision of the hip have led surgeons to be more chary in its performance, and to the employment of other, more conservative, steps.

Where the surgeon's surroundings admit of his securing skilled after-attention, especially as to the dressings, he will, in my opinion, do wisely to interfere early with the view of eradicating as far as possible the disease, short of an actual removal of the upper end of the

femur. The cases referred to are of course those in which either rest and fixity have not been adequately employed, or where these fail as shown by continued pain, increasing swelling and tenderness. If any abscess be present, this should be cut down upon by a free incision, but not, if possible, opened at once. All the superficial part of the abscess being isolated, and the adjacent parts protected by gauze, the abscess is then emptied and the wall clipped away with scissors. The curette (p. 899) should be used cautiously for fear of further infecting tissues whose vitality is greatly lowered, and chiefly for the less accessible part of the abscess tracks. Any such tracks being then plugged with gauze and pure carbolic acid or zinc chloride (gr. 20—1 oz.) the capsule is opened by an anterior incision sufficiently free to give adequate access to the whole upper extremity of the femur. Any escaping fluid, whether sero-pus or curdy and flaky, is most carefully mopped away and the bone examined for foci of disease, either patches of caries or spots of tuberculous osteitis. To enable this to be done with any chance of success, it is absolutely necessary that the dense fixed capsule be freely opened. The finger may now detect caries on the head of the femur, where the cartilage has been raised, blister-like, by deeper tuberculous osteitis. Another common region for such osteitis is on the under aspect of the neck. To expose these sufficiently for an adequate use of the gouge or curette, and to find other disease in the femur, it will often be needful to dislocate the head, aided by an elevator. This must be done carefully owing to the presence of delicate epiphysial tissues and the probably wasted condition of the small femur. Though at first sight severe, this step will often alone suffice for the finding and satisfactory dealing with bone disease. Moreover, displacement of the head, in my opinion, alone enables the surgeon to eradicate the synovial membrane especially at the back of the capsule; the difficulties of dealing with this have been already alluded to (p. 889). If the surgeon fails to find foci of bone disease, of the existence of which he is assured by the persistence of pain, the increase of swelling, &c., after displacing the head, and if he proceeds to open up the different epiphysial lines, he must be prepared to convert his conservative operation into an excision. While the head is still displaced the acetabulum is carefully examined with a finger and dealt with according to its needs with gouge and curette. The less accessible parts of any abscess tracks are now explored with probes and extirpated as far as is possible. The joint is next washed out with sterile saline or dilute sublimate solution, carefully dried, and swabbed over with iodoform and glycerine (10 per cent.). The head is then replaced. The anterior incision is only, in my opinion, to be sutured when the operator is able to feel assured that he has succeeded in eradicating the disease, and is leaving a dry wound. The same remark applies to drainage. Where one or more abscess tracks are present gauze wrung out of pure carbolic acid or zinc chloride solution will ensure this. In any case gauze is to be preferred to tubes.

If the above conservative treatment—the object of which is to secure as radical dealing with the disease as excision, without the resulting flail-like limb—is to succeed, absolute fixity and sufficiently prolonged rest are essential. In hospital practice, where expense is an object

and skilled anæsthesia readily secured, plaster of Paris strengthened with metal strips is the simplest and most efficient. Any windows required must be large enough to allow of resterilisation of the adjacent skin, a point of great importance and often forgotten. The plaster should reach from below the ribs to below the knee. It is obvious that attention to the above details requires time. This method is not to be employed at the end of a day's work, after other operations. To be successful, every step must pass under the eye of the surgeon responsible for the case.

Where the surgeon's surroundings are different—and one of the objects of this book is to help in widely differing cases—he is justified in resorting to a milder conservative method, viz., the injection of iodoform emulsion into abscesses and the joint itself, as advocated by the late v. Mickulicz of Breslau and other authorities. The weak points of this treatment are obvious. In the case of abscesses thickness of the pus may prevent anything like complete evacuation. The method makes no attempt to eradicate the bone lesions usually present.

In dealing with an abscess strict asepsis as to the skin, &c., is needful. A syringe holding 2—3 ounces should be employed, so as to allow of aspiration of the pus. The emulsion is then injected, the syringe being resterilised. A spray of ethyl-chloride may be used. The aspiration is repeated according to the rate at which the abscess re-fills. Where the process has to be repeated, fresh spots should be selected. If the re-collection takes place slowly and is found to contain only blood-stained or brownish-green fluid, the outlook is good. I need not enforce the necessity of watching these cases. Where the abscess is multiple, this method rarely succeeds, in my experience.

The joint itself may be injected by taking the line for opening the joint anteriorly (p. 897), and introducing the needle two to three inches below the anterior superior spine, in a direction backwards, upwards, and inwards, so that it enters the joint just above the anterior inter-trochanteric line. From 4 to 30 c.c. of the emulsion are injected at intervals of from one to two weeks, according to the reaction produced. Any pyrexia and pain are, usually, quite temporary.

Reference may here be made to an important contribution to the study of the treatment of hip disease by Drs. Gibney, Waterman, and Reynolds, of New York (*Ann. of Surg.*, vol. ii. 1897, p. 435). An analysis is given of 150 cases treated at the New York Hospital for the Ruptured and Crippled. Of these 25 were still under treatment, and need not be further considered; 7 were advised readmission for deformity, 11 died, and 107 were cured. The 107 cured cases were finally examined at an interval of five to twenty years after leaving the hospital. The excellence of the final result in the cured cases, all of which recovered with sound and useful limbs, will be gathered from the following facts. As regards motion, this was perfect in 15, good in 22, limited in 41, and absent in only 9 cases. Shortening averaged an inch and three-fifths in all the cases, but was absent in 21 cases; under one inch in 71, and over one inch in 36. The record as regards flexion is also extremely satisfactory, as 47 cases had none at all, and in 77 it was under 10°; in the remaining 30 cases it was under 30°. The treatment employed consisted essentially in rest and extension;

abscesses being either aspirated, or opened and curetted. Osteotomy of the femur was performed 19 times to correct deformity, but excision was done in 4 cases only.

Briefly stated, of 114 cases examined five years and upwards after leaving the hospital, 107 "were cured and able to follow an occupation without the slightest trouble," and the remaining 7 cases were cured but suffering from considerable deformity. As excision was performed in only 4 of these cases, it must be admitted that these excellent results constitute very strong evidence in favour of treatment other than that by actual excision.

In my opinion excision, while justifiable in the earlier stages because we are dealing with a tuberculous affection, gives after results inferior to those of the first of the conservative methods which have been described. Because of the condition of the limb which often follows later it is only to be employed when the surroundings of the surgeon ensure his keeping the resected joint fixed for a period of upwards of nine months and under his own eye in order to secure satisfactory consolidation of the parts. Otherwise I should reserve excision for those cases where the first of the conservative methods above given fails, or where the mischief found is considered too great for its success, for the rare cases where the acetabulum is chiefly diseased, or those, rarer still, where it is perforated. Examination per rectum or the presence of thickening or sinuses above Poupart's ligament may cause suspicion of the presence of these conditions. Finally, excision on one side is justifiable, at a later date, to remedy the deformity known as "scissors-leg," which occurs in bilateral hip-joint disease where the position has been neglected and the limbs allowed to cross one another in the adducted position.

Having given the results of my own experience, I shall now take those of two of the chief writers on hip disease and the subject of excision, Prof. Howard Marsh,* with his experience gained from Great Ormond Street and the Alexandra Hospital for Hip Disease in Childhood, and Mr. G. A. Wright,† of the Manchester and the Pendlebury Hospital for Sick Children. Prof. Marsh is strongly against excision, for these reasons: He considers the results obtained by continued rest to be such as to render excision totally uncalled for. "The estimate that I have been led to form is, (a) that, in the early stage of the disease, although matter is developed, the operation is as unjustifiable as it is to remove a testis, an eye, or a tooth for incipient but still curable disease; (b) that the operation is generally uncalled for, even when sinuses have formed; (c) that if hip disease has been allowed to reach the stage in which the bones have become extensively carious, in which matter has burrowed widely, and in which the general health has become seriously affected, excision will be of very doubtful benefit.

On the other hand, my old friend, G. A. Wright, speaking from the very large experience of over a hundred cases of excision, of which only three, at most, died of the direct results of the operation, strongly urges that the hip should be excised "as soon as there is any evidence of external abscess, . . . and still better results would, I believe, be obtained by operating before the pus has escaped from the articulation.

* *Diseases of the Joints*, p. 317.

† *Hip Disease in Childhood*, p. 93.

The operation is discredited because it is put off until disease is so far advanced that no treatment can have more than a fraction of good results; while timely excision cuts short the disease, saves pain, lessens the time of treatment, and gives a better limb.* And again, at p. 97 of his book, Mr. Wright says: "While fully aware that abscesses disappear and tuberculous lesions cicatrise under favourable circumstances, I think that, in the case of the hip, delay is unwise amongst the hospital class, with whom it is as yet impossible to deal on the same lines as with the well-to-do. In almost every instance I have found much more extensive disease than might be expected from the external evidence, unless the pathology of the affection is borne in mind; and I believe that, once this chronic osteo-myelitis is established, nothing short of excision can, *in hospital cases*, prevent the ultimate progress of the disease to abscess, and too often to gradual exhaustion of the patient by pain and discharge. Nature, of course, in many cases will, unaided, get rid of the dead bone by slow and tedious processes, but the number of children who can survive the process of elimination is very small, while the mortality after early excision is not great, and the failures are mainly in those instances where the operation has been put off till too late. Where actual necrosis, or caries of the head of the femur, with destruction of bone and cartilage, and often sequestra of varying size in the acetabulum, or at least caries of it, are known to exist, I think few advocates of non-operative treatment will be found." With reference to so wide a divergence of opinion between two authorities on the subject, it may be pointed out that both have worked under conditions more favourable than those which fall to the lot of most hospital surgeons. Thus, at the Alexandra Hospital, cases are kept under treatment as long as rest and extension are required; if an operation is called for, the case is transferred elsewhere. Mr. G. A. Wright gained especial experience from his long connection with the hospital at Pendlebury, one of the best children's hospitals in the kingdom.

The following are the conditions given by a committee of the Clinical Society as calling for excision, viz. :—

i. "Necrosis, and separation of the entire head of the femur, and its conversion into a loose sequestrum."*

ii. "The presence of firm sequestra either in the head or neck of the femur, or in the acetabulum." This question is a most important one, for, as Prof. Marsh (p. 318) writes, "much difference of opinion exists as to the frequency with which hard sequestra of any material size are present in suppurative hip disease." He himself thinks that, when present, sequestra usually consist of porous, friable bone. Their structure is such that, should excision not be performed, they will crumble away and disappear, and will not prevent repair.† A distinctly

* Prof. Marsh (*loc. supra cit.*, Fig. 50, p. 383) thinks that these cases are not rare. Mr. Hilton (*Rest and Pain*, Fig. 63, p. 341) shows a similar specimen. I should have thought the condition a very uncommon one.

† "This seems to be proved by the fact that in numerous cases in which profuse suppuration has been going on, so that there can be no reasonable doubt that extensive bone disease has been present, all the sinuses will close, although either no bone has worked out or been extracted. In these instances we must conclude either that no

different opinion is held by Mr. Wright (*loc. supra cit.*, p. 118): "Here opening of abscesses, and, still less, expectant treatment, can hardly be considered a satisfactory mode of getting rid of sequestra, yet in no less than in 39 (out of 100) were there actual loose sequestra, while in many others there were patches of bone which was practically dead, though not loose. The possibility of removing sequestra without a formal excision is worth trying in some cases, but it is often impossible to discover the presence of the sequestra until the end of the bone has been removed,* or to extract them if found. Moreover, even after the removal of sequestra, others may exist and not be found, and in other instances the disease progresses in the surrounding bone and necessitates subsequent excision. There are often, too, other foci of disease in the medulla, which are as great bars to recovery as the sequestra themselves."

iii. "Extensive caries of the femur, or the pelvis, leading to prolonged suppuration and the formation of sinuses."

iv. "Intra-pelvic abscess following disease of the acetabulum."

With reference to the two last conclusions I should doubt myself whether excision can be often justifiable, especially in the latter. Even if it gave the desired drainage the patient's condition with disease of the acetabulum is not one usually to give the required repair after excision. "Extensive caries" of the pelvis certainly, and in many cases of the femur, will require amputation, especially after childhood.

v. "Extensive and old-standing synovial disease and ulceration of the articular cartilages, with persistent suppuration." This condition is rarely seen in the hip-joint, where the disease, as usually met with, starts not in the synovial membrane, as in the knee-joint, but as a chronic osteo-myelitis in the neighbourhood of the epiphyses, especially the upper one.

vi. "Displacement of the head of the femur on the dorsum ilii, with chronic sinuses and deformity."

I have performed excision seven times for such cases; of these six recovered with sound and useful limbs. These patients seem to me to bear excision well, this being probably due to their having good vitality, as shown by their survival, and the amount of repair. Further, in running successfully the gauntlet of the disease, they have escaped the dangers of lardaceous and general tuberculous trouble. But as a rule, especially if the sinuses are few or closed, osteotomy, either cuneiform of the neck or by Gant's method, together with division of the contracted sartorius, tensor fasciæ, and adductor longus is much to be preferred. Excision does away with much of the stability of the limb, already secured. The surgeon here must, if he excise, be prepared for a good deal of trouble in dislodging the displaced head, after sawing through its neck, owing to its being firmly matted down by old adhesions.

sequestra were present, and in that case it would appear that sequestra are not so common as some believe, or that they often crumble away and are discharged, so that operative interference is by no means essential for their removal" (Marsh, *loc. supra cit.*, p. 319).

* For the word "removed" I should substitute "displaced," a step which I consider quite justifiable at the present day, to prevent the need of a complete excision and the flail-like limb which usually follows (p. 890).

The Condition of the Limb. Is this a better one after Excision or after a Cure by Rest?

Here, again, there is marked divergence of opinion. Prof. Marsh (*loc. supra cit.*, p. 308) is of opinion that "the limb after excision of either the hip or the knee is usually very inferior to the average limb that is obtained after recovery has followed the treatment by rest." The Clinical Society's Committee reported on this subject that, after excision, "movement is more frequently present, and is also more extensive, but that patients often walk more insecurely and with a considerable limp, while the limb, after treatment by rest and extension, though frequently more or less fixed, is more firm and useful for the purposes of progression." While feeling assured that the resulting usefulness in *some* cases treated by excision far surpasses the best results obtained by rest, I consider that the *average* result obtained by rest is superior to that following excision, and that this is increasingly marked after childhood, the limb, especially in adolescents recovering after excision, being very often flail-like and useless.*

On the other hand, Mr. Wright, whose large experience on this subject has already been referred to, has come to the conclusion (*loc. supra cit.*, p. 126) that "excision gives a better limb than the average result obtained without operation;" and again (p. 114): "In my own experience, useless, flail-like joints are exceedingly rare, and limited to those cases where the excision was performed in very late stages of the disease; the powerless condition is, I take it, the result of the disease, not of the operation." With regard to the shortening of the limb, he considers (p. 108), that "though some shortening must necessarily result, this arises mainly from the weight being borne upon the limb prematurely. . . . Growth in length of the femur takes place almost entirely at its lower epiphysial line, hence the loss of length or true shortening is only the distance from the line of section to the top of the head, coupled with such arrest of growth as may result from impaired nutrition, this last being, of course, a very inconstant quantity."†

Conditions of Success in Excision of the Hip.—Amongst these are: 1. Age. I consider the best six to fourteen. After eighteen excision should rarely be performed, amputation by the methods of Furneaux Jordan and Sir H. Howse (p. 884) taking its place. Mr. Wright (p. 126) thinks that after fifteen excision should be rejected in favour of amputation. 2. Absence of lardaceous disease. Excision should be performed, in my opinion, only before the appearance of lardaceous disease. When there is evidence of this condition having set in, especially in the kidneys or intestine, amputation is to be preferred. 3. Absence of advancing mischief in other joints, or of tuberculous lesions in the viscera—*e.g.*, the lungs. 4. The disease must be removed as entirely as possible. Thus, in the femur at least,

* Prof. Bruns, of Tübingen (*loc. infra cit.*), is of opinion that in the preservation of function the balance is greatly in favour of the conservative treatment as opposed to resection.

† On this matter Mr. Wright quotes Prof. Ollier's (*Rev. de Chir.*, 1881; *Ann. of Surg.*, Jan., 1886) estimate that, up to five years of age, the growth of the femur takes place about equally at its two ends; that, after five, the rate of growth of the lower end increases rapidly till it becomes three times that of the upper.

the section must pass below all foci of disease (p. 902). All sinuses should also be scraped out. 5. Adequate drainage. 6. Careful after-treatment, the wound, including the adjacent skin, being kept aseptic. 7. The patient must not be kept too long on his back in ordinary hospital air. These words must not be taken to encourage getting the patient up, still less allowing him to bear any weight on the limb, even if primary union has been secured, eight weeks or so after the operation. This liberty is not to be given for nine months or more, if the limb is to be a stable and satisfactory one.

B. Gunshot Injuries.

Excision of the Hip-joint for Gunshot Injuries, contrasted with Conservative Treatment, and Amputation at the Hip-joint.—For the sake of convenience it will be well to take the above three plans of treatment of gunshot injuries of the hip together. As before, I shall avail myself of the laborious researches and the unrivalled authority on this subject of Dr. Otis. He writes (*Med. and Surg. Hist. of the War of the Rebellion*, pt. iii. p. 165) that the evidence collected during the American war shows that "expectant treatment is to be condemned in all cases in which the diagnosis of direct injury to the articulation can be clearly established," that "primary excisions of the head or upper extremity of the femur should be performed in all uncomplicated cases of shot fracture of the head or neck;" that "intermediary excisions are indicated in similar cases where the diagnosis is not made out till late;" that "secondary excisions are demanded by caries of the head of the femur or secondary involvement of the joint;" that amputation should be performed—"1. When the thigh is torn off, or the upper extremity of the femur comminuted with great laceration of the soft parts, in such proximity to the trunk that amputation in continuity is impracticable. 2. When a fracture of the head, neck, or trochanters of the femur is complicated with a wound of the femoral vessels. 3. When a gunshot fracture involving the hip-joint is complicated by a severe compound fracture of the limb lower down, or by a wound of the knee-joint."

Other authorities have differed from Dr. Otis's opinion as to the uselessness of expectant treatment in gunshot injuries of the hip-joint. Prof. Langenbeck,* from his experience in the Franco-German war, considered that the expectant treatment gave a larger proportion of recoveries than excision, and still more than amputation, and advised that the expectant method should always be resorted to save when disarticulation is rendered inevitable by the destruction and shattering of the limb. Sir T. Longmore (*Syst. of Surg.*, vol. i. p. 561), thought that this question must be held to be still "*sub judice*, and surgeons must wait for still more extended experience under modern improved methods of treatment, before any rule can be accepted as having yet been established on this grave question."

Dr. Otis shows that "intermediary operations offer the least chance of recovery."

The experience of the Boer campaign, one where the proportion of shell wounds was very small, has been widely different.

Mr. G. H. Makins, C.B. (*loc. supra cit.*, pp. 193 and 238) saw no case of perforation of the head or neck of the femur, nor of injury to the hip-joint.

Operation.—Two will be described here: A. By Anterior Incision; B. By Posterior Incision.

A. Mr. A. E. Barker,† in his Hunterian Lectures (*Brit. Med. Journ.*, 1888, vol. i. p. 1326) advocated the use of the anterior method

* *Arch. f. Klin. Chir.*, 1874, Bd. xvi. S. 309-316. The recoveries seem to have been twenty-five out of eighty-eight cases so treated.

† Mr. R. W. Parker (*Clin. Soc. Trans.*, vol. viii. p. 108) recommended this method as interfering less with the muscles and the blood-supply of the joint. Hüter was, I believe, really the first to use this incision, draining the joint by a counter-puncture at the back.

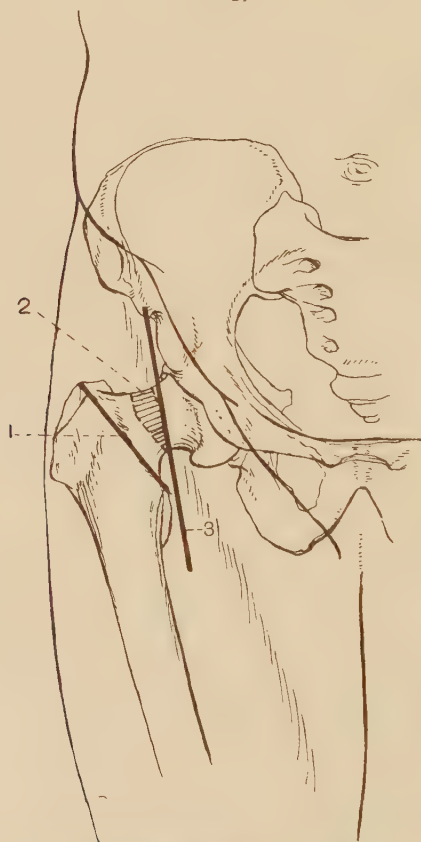
in the early stage of hip disease. In later papers (*ibid.*, 1888, vol. ii. p. 1337, and 1890, vol. ii. p. 1009) he published some most successful cases thus treated in later stages, where other means had failed, and abscesses were threatening to burst. The following are the chief advantages: (1) the interference with the muscles is practically *nil*; (2) the patient can thus be treated and his wound dressed much more conveniently—*e.g.*, with a Thomas's splint; (3) primary union will follow if the following most essential points can be secured: (*a*) the whole of the diseased structures must be removed; (*b*) perfect asepsis must be secured; (*c*) all oozing must be checked, and the wound kept dry by well-applied dressings; (*d*) absolute rest must be maintained during healing. With regard to the objection which has usually been considered to be fatal to the anterior incision—*viz.*, the insufficient drainage which it gives—Mr. Barker replies that the incision, though anterior, is perfectly adequate for drainage, (1) because the discharges are, if the above given precautions are duly followed, very small in quantity, "little more than odourless serum, which ought never to become truly purulent"; (2) "if all the tubercular tissue is removed, a clean-walled cavity is left, most of which is quite capable of healing by first intention, when its different surfaces are brought into close contact by firm pressure. And, in these cases, the head of the bone being removed, and the acetabulum quite clean, the cut surface of the neck of the femur can be brought close up to the latter, so that although there is potentially a large space in the field of operation, there ought to be actually little or no cavity left, if pressure has been properly applied from the first."

Of the conditions which it is absolutely necessary to secure for the obtaining of primary union, and the success of the anterior incision, the first—that the whole of the diseased structures must be removed—is by far the most important. It is also, from my experience, the most difficult to secure. G. A. Wright (*Brit. Med. Journ.*, 1888, vol. ii. p. 1338), speaking at the discussion on one of Mr. Barker's papers, said that he had found the entire removal of the morbid tissues practically impossible either by the anterior incision which he used occasionally, or by the posterior. Only little foci of disease might be left, but they were apt to suppurate when some fall or accident gave them the opportunity. And this will be the experience of most, particularly with regard to the acetabulum, and synovial membrane at the back of the capsule.

Operation.—The patient being on his back, with the limb extended, and the parts duly sterilised, the surgeon standing, in the case of either limb, on the right side, makes an incision three to four inches long, starting half an inch below the anterior superior spine, downwards and slightly inwards, between the tensor vaginæ and glutæi externally and the sartorius and rectus internally. The upper part of this incision should pass down to the capsule at once, the lower third should divide skin only. The interval between the above-named muscles is next thoroughly opened up and the wound retracted, so that the anterior surface of the capsule is exposed. A branch of the external circumflex artery will now, probably, be divided. The capsule now being freely opened, and the limb flexed, the left index finger is passed into the joint. As the difficulty which is sometimes experienced in

removing the head is usually due to an insufficient division of the capsule, this is now further incised with scissors, the left index finger being used as a guide. An aseptic finger now examines the condition of the joint. The wound being opened by retractors, a narrow-bladed saw, guided by a finger, is introduced into the upper part of the wound in the direction of this, and with as little damage to the soft parts as

FIG. 370.



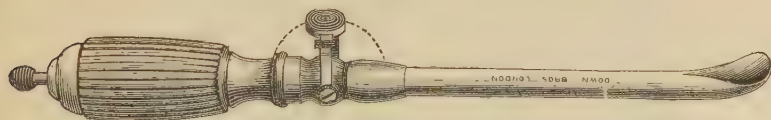
(1) R. Jones's line of section through trochanter. By this trans-trochanteric osteotomy, followed by traction and abduction, Mr. R. Jones has been able to obliterate or very greatly lessen the shortening in a very large number of cases of bony ankylosis. (2) Cuneiform osteotomy for coxa vara. (3) Anterior incision for excision of the hip (MacCormac).

possible, and the femur sawn through the neck, or across the top of the great trochanter.

The advantages and disadvantages of these sections are given below at p. 902. In a case at all advanced there will always be a risk that a section through the neck will expose diseased bone. The head of the femur is now extracted and the acetabulum treated by the means given at p. 902. Owing to the depth at which it lies there is usually difficulty in dislodging the head of the femur. Its direction must be remembered, and the narrow interval between its

articular surface and the acetabulum detected. A free opening in the capsule will facilitate its extraction. In the use of elevator or forceps care must be taken not to damage the sawn edge of the femur (p. 902). Every atom of diseased structure, including all the synovial membrane that is accessible, must now be removed, especial care being taken to clear out any caseating abscesses communicating with the joint. All this should be done with as little violence as possible to the surrounding tissues, the lowered vitality of these being remembered, so that none of the tuberculous *débris* be forced into the fresh-cut surfaces. The best instrument for removing the disease thoroughly is Mr. Barker's "flushing gouge" (Fig. 371). This has a cutting scoop-like edge, is perforated, and to its belt is attached tubing which communicates with an irrigating can. By this means boiled water (F. 105°) is kept flowing through the area of operation, carrying away the *débris* of disease whether from abscess cavities, the joint, or the surface of the acetabulum, if diseased, and with it all blood, while at the same time it arrests hæmorrhage. When every part of the field of operation has been gouged and scraped clear of all tuberculous material, and the water runs clear, the cavity is dried out with sterilised pads, one or two of which are left in it until all the sutures are *in situ*, if the surgeon

FIG. 371.



Barker's flushing gouge. (Down's Catalogue.)

decide to close the wound, a step, in my opinion, very rarely advisable (p. 897). These should dip deeply, and be placed close together. Just before they are tied, the sponges are removed, and with them the last trace of moisture. The wound is then filled up with iodoform emulsion, and the sutures are tied, as much of the emulsion as will come away being squeezed out at the last moment. Graduated even pressure is then applied by the dressing and bandages, so that the walls of the cavity are brought into apposition, and the remainder of the neck of the femur secured in the acetabulum. The patient is then placed in a double Thomas's splint. If sinuses are present, and the joint infected, the wound must not be closed, but drainage must be provided. All sinuses, having been thoroughly opened up and curetted, must be plugged by means of strips of iodoform gauze passing down to the bottom.

With regard to the after-treatment I would urge that cases of hip excision should be got up as early as possible—*i.e.*, at the end of six or eight weeks. A double Thomas's splint, with foot-pieces, should be applied immediately after the operation, and worn for a period of from six to eight months. After this the child should get about on a patten and crutches, swinging the affected limb. He should not be allowed to bear any weight on this for a year after the operation. If weight is borne on the limb earlier, the end of the femur is pushed upwards on to the dorsum ilii, and much shortening is the result.

Mr. Barker has allowed some of his cases to get up and dispense with a splint at a much earlier period. I think the above-given dates better suited to these cases of excision of the hip, when we remember the risks to which they are exposed by their rough-and-tumble life when they leave the hospital.

B. Posterior Incision (Figs. 372, 373).—The chief advantage of this is its better drainage, a point which is of less importance nowadays, and which no longer outweighs, in my opinion, the smaller interference with muscles entailed by the incision in front (p. 897).

FIG. 372.



Resection of the head of the femur by the posterior incision. The thigh is flexed to an angle of 45° . The gluteus maximus has been divided, allowing the great trochanter to come into view. The retractor draws aside the skin, the upper part of the gluteus maximus, and the medius. Below it is the piriformis. (Farabeuf.)

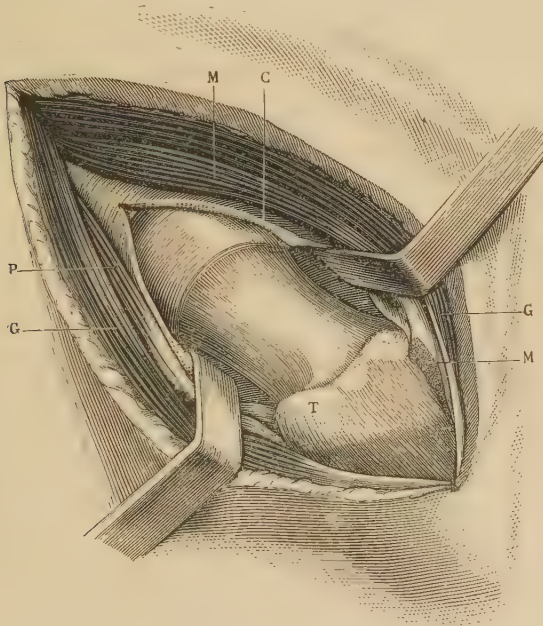
While the patient is being brought under ether, a stirrup is applied if weight-extension is to be made. The child being rolled over on to his sound side, and the parts thoroughly cleansed, the surgeon stands usually outside the limb, the patient's body being in either case placed conveniently at the edge of the table, one assistant supporting the limb, while another is opposite to the surgeon. An incision, about three inches and a half long,* is now made over the middle† of the great trochanter, commencing about midway between the top of the bone and the posterior superior spine, and ending over the shaft, just below the trochanter:

* It must be always remembered that a small wound, by giving insufficient room, leads to bruising and difficulty.

† The advantage of going so far forward as this is, that the fleshy and vascular part of the muscles attached to the great trochanter are better avoided.

The incision should curve slightly forwards and pass down to bone or cartilage, as the case may be, at once. Any bleeding vessels having been secured, the exact position of the head and neck is now made out by the finger, aided by an assistant rotating the limb. A second incision opens the capsule freely. With a periosteal elevator, aided by a knife, the muscles attached to the great trochanter are detached, the cartilage in young subjects peeling off with them in one or more pieces. The finger is now passed round the neck of the femur and the soft parts, including the periosteum, detached as much as possible on the inner side. The finger now feeling that the upper part of the trochanter and the neck of the bone are free, and protecting the soft parts on the inner side, the bone is sawn through just below the top of the trochanter with an osteotomy, metacarpal, or keyhole

FIG. 373.



Excision of the head of the right femur. Separation of the capsule and periosteum has been thoroughly performed. G, Glutæus maximus. M, Medius. C, The capsule opened. P, Pyramidalis. T, Great trochanter. The upper retractor raises the upper lip of the glutæus maximus, the medius, the minimus which is hidden, and the capsule. The lower retractor depresses the pyramidalis and the capsule. (Farabeuf.)

saw.* This division should be thoroughly and cleanly effected without splintering. If it be preferred, in addition to the protection of the finger on the inner side, a blunt dissector may be passed behind the bone, but this is not essential: retraction will protect the lips

* It is usually advised that the section of the femur be made while the bone is *in situ*, owing to the risks of fracturing a wasted shaft, inflicting damage on weak epiphysal lines and stripping off the periosteum. But these accidents will be very exceptional in careful hands, and there is no doubt that displacement of the head (by adducting the limb) facilitates complete removal of the synovial membrane, especially its posterior and less accessible portion. Finally, careful dislocation of the head does away with the difficulty, often present, of turning it out of its socket after the bone section has been made *in situ*, and the resulting damage so easily inflicted on the upper end of the shaft of the femur (*vide infra*).

of the wound from the saw. With the aid of the finger and an elevator, or with a lion-forceps, the head and neck of the bone are levered out of the acetabulum, this being often attended with difficulty. Free opening of the capsule will aid this step. But great care is now needed to avoid infliction of damage on the sawn femur. Such damage is very likely indeed to lead to tuberculous infection of the bony section. This *must* be left clean cut and uninjured. Any instrument used must be directed to the head itself. The ligamentum teres is probably destroyed; if not, it must be divided. The acetabulum is then examined, and, if merely roughened, left alone; if pitting or erosion be present, gouging must be resorted to. Any sequestra present must be removed. If the acetabulum is perforated, and pus present on its pelvic aspect, free exit must be provided by means of a gouge or small trephine, and a drainage-tube passed through.

The inner surface of the capsule and all abscess cavities must now be thoroughly curetted and irrigated by means of a flushing spoon, as described above, until all granulation tissue and caseous *débris* have been removed. If sinuses are present, these must be carefully curetted and treated with pure carbolic acid (p. 890). Hæmorrhage is usually very slight, and with the exception of a few vessels, which may be caught with forceps, usually consists of a general oozing. This will usually be stopped by the hot irrigating fluid; if, however, it is troublesome, the cavity may be packed with gauze.

Drainage, either by means of iodoform gauze or a tube, will be necessary in nearly all cases. In a very few, however, where no sinuses exist, where all disease in bone and soft parts alike has been removed, and where all oozing has been arrested, a little sterilised iodoform emulsion may be rubbed in and the wound partially closed with sutures. The dressings must be carefully applied and firm pressure used to prevent oozing.

Site of Section of the Femur.—Section through the root of the neck of the femur has the great *advantages* of disturbing and damaging the attachments of muscles much less, and thus leads to more rapid healing and far greater mobility of the limb. These, however, are outweighed by the *disadvantage* which leaving such a large piece of bone as the trochanter entails—viz., that, after healing, this process gets drawn up against the scar and may constantly fret it.* It is also said to check the escape of discharges, and to render the patient liable to persistence or recurrence of the disease. I am doubtful as to the last two, but the first is absolutely certain, unless prolonged rest is enforced. Where the section is made through the neck, the surface must be carefully scrutinised.

Usual Causes of Failure after Excision of the Hip.

1. Persistent pelvic disease. 2. Chronic osteomyelitis of sawn end of femur (*vide supra*). 3. Suppuration and hectic. 4. Lardaceous disease. 5. Tuberculous conditions elsewhere. General outbreak of tuberculosis. 6. Disease of the opposite femur.

Operations for Rectifying Deformities in the Later Stages of Hip-Joint Disease, such as a cuneiform osteotomy of the neck, or Gant's sub-trochanteric operation, are described below in the chapter on Osteotomy.

The anterior incision should be used to open the joint in *cases of infective arthritis and epiphysitis* occasionally met with here. Owing to

* About eighteen years ago I made use of this method in one case, sawing the bone through the neck and leaving the trochanter entire. A rapid recovery took place, and the boy was allowed to begin to use his limb seven weeks after the excision. He quickly regained power over the limb, becoming able to run and climb like other lads, the movements of flexion, extension, abduction, and adduction being extraordinarily perfect. He came, however, under my care on several occasions for superficial ulceration of the scar, which was fretted by the very prominent upper margin of the immediately subjacent trochanter.

the gravity of these cases, and the difficulty of flushing out the joint thoroughly with sterile saline or weak sublimate solutions, the head and neck of the femur should usually be removed, attention being paid only to the patient's life, and not to the after condition of the limb. Drainage should, in every case, be provided behind by a counter-puncture in the buttock, made with a pair of stout forceps thrust through the back of the capsule from the wound in front.

I only mention the subject of excision in *osteoarthritis* to condemn it, owing to its severity in patients of the usual age at which this disease appears, and the impossibility of preventing re-appearance of osteophytes. I can imagine the operation being justified in patients who are crippled at an unusually early age, in whom both joints are affected, the operation being performed in the hope of enabling them to bend one hip-joint.

CHAPTER II.

OPERATIVE INTERFERENCE IN DISLOCATION OF THE HIP. COXA VARA.

HERE three varieties of cases have to be considered: I. TRAUMATIC DISLOCATIONS. II. DISLOCATION FROM DISEASE (this is rather a partial dislocation, or a subluxation). III. CONGENITAL DISLOCATIONS.

I. TRAUMATIC DISLOCATION.—The great deformity, permanent crippling, and often great suffering resulting occasionally from old unreduced dislocations of the hip, abundantly justify resort to operation, nowadays, as long as it is understood that the operation will be a severe one, and the after-treatment one requiring great vigilance on the part of the surgeon.

In an excellent paper (*Ann. of Surg.*, Sept. 1894, p. 319) Dr. M. L. Harris, of Chicago, publishes an instructive case of his own and twenty-four others which he has collected. From these he draws the following conclusions: (1) Owing to the danger of fracturing the neck of the femur (*Arch. f. klin. Chir.*, 1885, Bd. xxxii. S. 440); of laceration of the great vessels of the thigh (*Ann. of Surg.*, June 1892, p. 425),—here, in an attempt to reduce by manipulation an obturator dislocation of thirteen weeks' duration in an adult, a fatal tear was produced at the junction of the superficial and deep femoral veins; or of shock and death (*Rev. d'Orthop.*, Sept. 1890), the application of great force to reduce old dislocations of the hip should be discontinued in favour of freely opening the joint and reducing the head of the bone, after the method used by Dr. Harris (*vide infra*). (2) Subcutaneous operations in old dislocations are without benefit. (3) As osteotomy below the great trochanter leaves the head in its abnormal position, and thus fails to relieve the pain which so frequently accompanies these old dislocations, and as it cannot improve the limited mobility which is always present, it is not to be considered in any way an operation of choice. (4) Resection is only to be thought of when reduction after free arthrotomy fails.

The following are the steps of the **operation** performed by Dr. Harris in his case of dorsal dislocation of nearly four months' standing, in which repeated and prolonged attempts at reduction had been made:

A free incision was made between the tensor vaginae femoris and the glutæus medius, thus leading directly down to the acetabulum and anterior surface of the head and neck of the femur. As was expected, the acetabulum was found filled with a tough, adherent connective tissue proliferation* from the anterior portion of the capsular ligament, which, in falling over the cavity, completely closed it. On cutting through the capsular ligament, the head of the bone was found resting on the posterior and superior edge of the acetabulum in a shallow depression, the lining of which had a smooth cartilaginous feel. Immediately in front of the head and helping to fill the cotyloid cavity was a small piece of bone, curved in shape, which had been detached from the posterior wall of the acetabulum. This may have been an obstacle to the early reduction of the case.

* In a case of traumatic dorsal dislocation in a boy, aged 7, reduced after five months by the open method, and brought by Mr. Spencer before the Clinical Society, Feb. 8, 1895, a long anterior incision showed the acetabulum to be filled with dense fibrous tissue. It is stated that the acetabulum could not have been reached by a posterior incision without resecting the head of the bone.

The head of the bone was still covered with smooth cartilage, while the neck had acquired new firm adhesion to all the surrounding parts, thus producing a new capsular ligament.

Only a small portion of the ligamentum teres was present in the depression in the head when this was turned out of its new joint. The adhesions to the neck were divided, and all the muscular attachments to the great trochanter and shaft as far down as the lesser trochanter were separated sub-periosteally from the bone, thus liberating the entire upper end of the femur. Attention was then directed to the acetabulum, which, by means of the gouge and sharp spoon, was freed of capsular ligament and the new connective tissue formation. The cartilage lining the bottom of the cavity was found to be still smooth. The head of the bone, however, could not be made to enter the acetabulum, which seemed too small. The cavity was consequently enlarged somewhat posteriorly with the gouge and mallet, after which, by considerable exertion and manipulation, the head was finally returned to its place, and the leg assumed its normal position. The wound was partly stitched, and the rest packed with iodoform gauze. The limb was placed in the extended position, plaster of Paris put on, and extension applied. The operation was a very severe one, occupying fully two hours. The patient suffered considerably from shock, although the loss of blood was not great. Reaction came on promptly, and the progress of the case was favourable from the start. There was considerable serous drainage from the wound during the first few days, necessitating rather frequent renewals of the dressings. In three weeks the wound was closed, but in another week a small collection of sero-pus required evacuation by a counter-puncture. The extension was continued three weeks. Six weeks from the time of the operation the patient was allowed up on crutches. In three months he could walk with a cane without pain in the hip. Active motion was possible in all directions—flexion, abduction, adduction, and rotation; these, though limited, were daily increasing.

II. DISLOCATION FROM DISEASE.—This has been referred to at p. 894.

III. CONGENITAL DISLOCATIONS.—Operative interference in this condition should not be undertaken unless the bloodless method of reposition by manipulation has been given a fair trial, and has failed. Even then the advisability of operative interference here is still much disputed. When we consider the condition of the parts affected, especially the shallow, ill-developed acetabulum, and the altered flattened head, we can easily understand the difficulty which has been met with in getting the head into, and retaining it in, a satisfactory position.

Mr. Jackson Clarke, whose book on "Congenital Dislocation of the Hip," 2nd ed., 1905, contains the clearest account of Lorenz's manipulative method with which I am acquainted, and one based on much personal experience, goes farther than the above statement and sums up the position of the open operation as follows (p. x.):—"It should not be performed in any case in which manipulative reposition is impossible, and, where the latter can be done, it is safer, and alone gives far better functional results than the open operation. Therefore the open operation is no longer a legitimate surgical procedure." Later in his work Mr. J. Clarke is inclined to allow a little more latitude, implying that there may be a few cases in which an open operation is justifiable. Thus he writes at p. 21: "Lorenz's manipulative method in a considerable proportion of cases gives a perfect anatomical and physiological result (*i.e.*, it cures a condition hitherto deemed incurable); in a still greater number of cases it affords a permanent functional improvement that relieves the patient of the grievous disabilities which the deformity entails if untreated. In the remaining cases in which this method fails to give a firm articulation placed anteriorly, the

manipulative operation of Lorenz is a necessary preliminary to any subsequent treatment by open operation that may be undertaken."

In his characteristic endeavour after accuracy Mr. J. Clarke prefers the term "manipulative" to bloodless because (1) some effusion of blood must take place during the subcutaneous division of the adductor longus and it may be the deeper adductors by careful repeated "hacking" strokes made with the ulnar border of the hand; (2) when these muscles are unusually resistant, it is wise to divide them subcutaneously with a tenotome.

Indications for Operation.—No one who studies the results which have been progressively attained during the last few years will feel any doubt that with increasing experience and careful attention to the details of Lorenz's technique, not only at the time, but during the nine or twelve months which follow, the number of perfect results will increase.* Where a perfect result, *i.e.*, an actual replacement of the head within the acetabulum and its retention there, as proved by skiagraphy, six months after the removal of all casing, is not secured, but merely an improved position, *e.g.*, an anterior transposition, not a true reposition, if this transposition has brought the head of the femur near the acetabulum, and if this new resting place is made secure by attention to the after-treatment insisted upon by Lorenz so as to secure sound healing of the torn structures and to prevent a relapse, either anterior or supra-cotyloid, or still more a posterior or dorsal one, the result will be a great improvement.† Thus many of the chief deformities characteristic of congenital dislocation, *viz.*, the shortening, the lordosis, and the insecurity will be largely removed, and a good functional result will be secured.

Operation.—In those cases where it has been found impossible to secure or to maintain a sufficiently improved position, where the child is over five or six years and therefore more easily kept clean, but not of such an age that the structures have become so rigid that the head cannot be brought near the acetabulum, the following method may be employed; the chief changes in the structures and the difficulties that may be met with will be manifest. If the adductors and hamstrings are very rigid these must be dealt with at a preliminary stage. By extension the head is drawn down to the level of the hip-joint. The incision given at p. 897 is made and its upper part prolonged along the crest of the ilium in order to detach the origin of the tensor fasciæ and the deep fascia (Burghard, *Brit. Med. Journ.*, Oct. 19, 1901, p. 1157). The tensor is retracted and the extended limb rotated outwards. The capsule is next freely incised parallel with the anterior inter-trochanteric line and the head protruded. If the ligamentum teres interfere with this, it should be divided. With a sterile finger the condition of the

* Mr. J. Clarke is of opinion that those who speak of the perfect results attained by Lorenz's method being few and isolated have not really mastered the details of his technique.

† The different results which may be attained short of a perfect one and the necessary treatment, exercises, &c., to secure further improvement are given in detail by Mr. J. Clarke (*loc. supra cit.*). On this subject my readers should also refer to a paper by Dr. J. Ridlon, of Chicago (*Journ. Amer. Med. Assoc.*, 1904, pp. 1011 and 1063). The paper is a very helpful one from its straightforward candour, and from the fact that Dr. Ridlon, like Mr. Clarke, has been associated with Lorenz.

acetabulum is investigated. I shall suppose that one exists though small, and I would here point out that the safety of the operation largely turns on the degree to which the acetabulum and head of the femur are developed; the difficulties and dangers of the operation increase greatly when this is not the case. The obstacles to the re-entrance of the head may now be found to require division of the ilio-psoas at its insertion (Burghard), the straight head of the rectus at its origin (Keetley, *Orthopædic Surgery*, p. 297), or to be due to resistance of the capsule and a narrow slit-like condition of the cotyloid ligament. With regard to the capsule, any unnecessary division must be avoided, as it is one of the chief means of restraining and steadying the head later, and the introduction of sutures is a possible source of infection. If it be a slit-like condition of the cotyloid ligament which cannot be sufficiently dilated by the pressure of the head, this structure, with the anterior attachment of the capsule to the acetabulum, together with the straight head of the rectus, must be carefully detached with a periosteal elevator. The head can usually now be placed in its proper position by the manipulations of Lorenz. It remains to replace the separated capsule and to tighten this by sutures of sterilised catgut or silk. The question of drainage must depend upon the extent to which the parts have been disturbed, and the dryness of the wound. The limb is then put up in plaster of Paris in the abducted, outwardly rotated, and slightly flexed position. To provide inspection of the wound, Mr. Burghard employs a form of Croft's splint, consisting of a posterior portion embracing the posterior two-thirds of the buttocks, pelvis, thigh, and leg; the other half embraces the anterior portions, and can be taken off for inspection of the wound. The knee, in the flexed position, is included in the plaster. At the end of a month a large plaster spica is substituted, and the abduction slightly diminished. An X-ray photograph is taken at the same time.

Up to this point the conditions met with have been comparatively simple and easy to deal with. But there are other cases which present an entirely different aspect. To take those where the acetabulum and head of the femur are totally inadequate. With regard to the first, and deepening or making a new acetabulum, it should be superfluous to point out how the difficulties and dangers of the operation, especially shock, hæmorrhage, and infection, are increased. And if these are satisfactorily met, the ultimate after-result is liable to be very disappointing. On this point Mr. Burghard's opinion on the results of Mr. Lane's operation, the object of which is to make a secure joint below the anterior inferior spine, deserves careful attention. "I have tried it in five cases and have been invariably disappointed with the results. The space available for the formation of a new acetabulum is extremely small, and in order to get a stable joint it is necessary to so whittle down the head of the bone that it becomes a mere point and firm ankylosis is likely to result. If not, the joint becomes gradually unstable, and the final condition is no better than before operation." Every surgeon of experience will confirm Mr. Burghard's opinion. Hoffa himself, in his article in v. Bergmann's *Surgery* (*Amer. Trans.*, vol. iii. p. 413), dismisses the formation of a new acetabulum in four and a half lines, as if it were a simple and easy matter. It is a matter of great difficulty to ensure that "the new cavity be deep and broad and

the walls fairly steep, especially above, to give good support to the head." It requires most careful and arduous work with gouge and burrs to form a new cavity even large enough to bury the last joint of an adult thumb. One operator has been candid enough to record a case in which perforation of the bone took place at this stage with fatal peritonitis. When the head and neck of the femur are faulty in direction rather than in development, *i.e.*, directed forwards instead of inwards, this may be first corrected and the dislocation reduced later. When the head and neck are practically absent it is extremely doubtful if any operation will be of real permanent value. Our experience up to the present time justifies the following conclusions. Between the ages of about two and six—I repeat that the amount of rigidity present is a more important factor than the number of years—one or more attempts should always be made to secure a perfect or much improved result by the manipulative method perfected by Lorenz. If the details insisted upon by this authority are followed at the time and during the needful after-treatment, good results will be increasingly secured. If the surgeon fail, and also in the case of rather older children, *i.e.*, from the ages of six to about eight, it will be justifiable to operate on the lines given above. When the acetabulum and upper extremity of the femur are sufficiently developed and normal in direction and position to admit of their being refitted, the result will often be good. In other cases, it is very doubtful if the results ultimately attained are worth the risks which are necessarily run.

Risks and Causes of Failure—The chief of these are: 1. Shock. 2. Hæmorrhage. 3 and 4. In children the effects of a prolonged anæsthetic and of iodoform intoxication must also be remembered. 5. Infection. 6. Prolonged suppuration increasing the risk of 7. ankylosis. 8. Relapse into a faulty position. Other rarer but possible accidents, such as that of peritonitis, have been already mentioned. Finally, in cases where much difficulty is present, it is obvious that the dangers which have been met with in the manipulative method must be remembered here also. I refer, especially, to injury to the delicate epiphyses and shaft and neck of the femur. These, and many others, are mentioned by Dr. Ridlon and Mr. J. Clarke, especially the former (*loc. supra cit.*).

CURVATURES OF THE NECK OF THE FEMUR. COXA VARA.*

Indications for Operation.—These are, chiefly, a degree of deformity in which such shortening, fatigue after walking, stiffness in stooping and sitting are present that rest will not permanently relieve the pain, or exercises, active and passive, increase the range of movement. No operation should be undertaken in children or adolescents while there is any reason to believe that the bones are still soft,[†] and if the patient

* This term is convenient, but only correct when one curve is spoken of. More than one curve may be met with.

† Mr. Kestley, to whom belongs the credit of first performing osteotomy (sub-trochanteric), in a case due to rachitis adolescentium and proving this by examination of the wedge removed (*Illus. Med. News*, Sept. 29, 1888), gives the following important hint

operated on be rapidly growing with poor development of muscles and joints, prolonged rest and general treatment will be required if a satisfactory result is to be attained. An occupation involving hard work, or carrying heavy weights is, in my opinion, an indication for operation, if the above-mentioned condition can be secured.

Operation.—Two groups may be made here: **A. On the neck.** **B. Sub-trochanteric.** Owing to the healthy condition of the joint, excision may be set aside, though still highly thought of by some German authorities.* Contrasting these two methods briefly, I consider that the younger the patient the more is a sub-trochanteric operation indicated. In children the parts are too small to admit of easily meeting the necessity of so arranging the wedge that when the gap is brought together the proper position of the femur is restored. In older patients, where the parts are larger and the elongation of the upper margin of the neck more pronounced, it is easier to secure the above object, but in these patients opening the joint, which it is difficult to avoid, is more likely to be followed by stiffness. In my opinion a sub-trochanteric operation is always to be preferred. Certainly osteotomy of the neck should never be employed unless a skiagram shows that the lengthening of the neck is enough pronounced to render removal of a wedge likely to be sufficient. Linear osteotomy alone is not likely to be satisfactory in cases of sufficient severity to call for operation.

A. Cuneiform osteotomy of the neck (Fig. 370).—The parts are exposed by the anterior incision already described (p. 897). The upper margin of the neck is the spot to which attention must be directed, and in separation of the periosteum and other structures care must be taken not to inflict needless damage on the epiphysal structures or the joint. It will be remembered that the epiphyses here are late in joining, and that rachitic changes may be more or less active up to certainly as late as eighteen years. The base of the wedge should be upwards and usually forwards; according to the degree of the deformity it will measure from one to two inches. The wedge must be cut cleanly with a chisel, and through to the inner border, which is always short. In removing it the above given precautions as to injury to adjacent parts must be remembered.

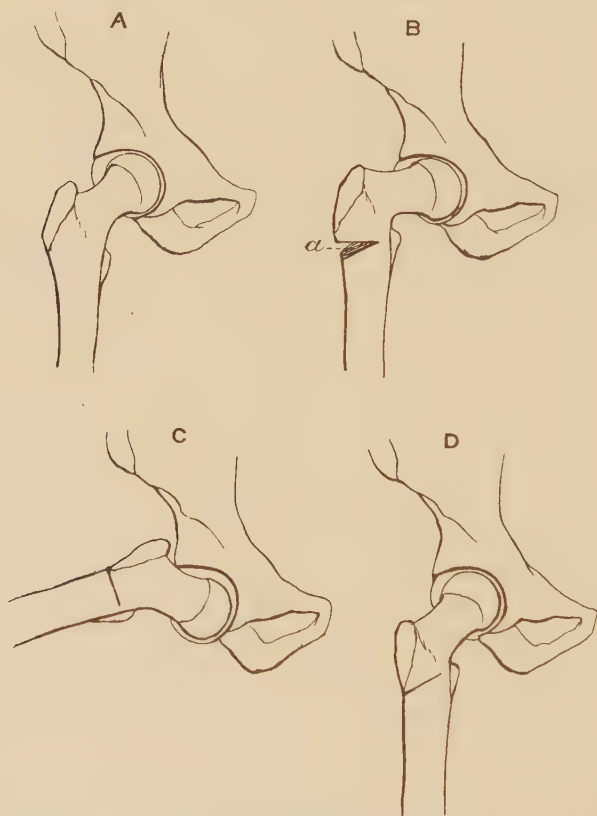
(*Orthopædic Surgery*, p. 312): "Adolescents attacked with rickets do not present the same clinical picture as infants. . . . The older a person is when attacked with rickets, the more limited and localised are his deformities likely to be."

* Prof. Hoffa (v. Bergmann's *Surgery*, *Amer. Trans.*, vol. iii. p. 517) writes: "Resection of the joint is best for the severe cases. The improvement in the gait and general condition in the majority of cases of resection verify its value (Müller, Hoffa, Kocher, Maydl, Sprenger, and others). In the case which the author resected the shortening was reduced from $2\frac{1}{2}$ to $1\frac{1}{8}$ inches. The importance of gymnastics and massage after the extension is removed is self-understood." It is difficult to understand the above statement with regard to the shortening if the case had been watched for any length of time. With regard to the adoption of this step, Mr. Keetley writes in his usual terse and vigorous style: "What is to be thought of reports like the following (reference to one of Schneider's cases): 'Patient limps, but has no pain. Treatment: Resection of the hip-joint. The patient was discharged cured.' Cured! What of? Not of the limp, we may be sure; not of the adduction either, unless bony ankylosis ensued; nor of the shortening. Increased mobility may have been obtained, but at the expense of increased weakness and diminished length."

Before the necessary correction into the abducted, everted and rotated inwards position can be satisfactorily secured, division of the adductors and hamstrings may be needful, now, or as a preliminary measure.

B. Sub-trochanteric osteotomy (Fig. 374).—Here the osteotomy has been linear, transverse, oblique from without inwards, or cuneiform. Theoretically, as the neck is the part primarily affected, interference

FIG. 374.



A. A normal femur. B. A femur with coxa vara. *a*. A sub-trochanteric wedge has been removed. C. Abduction first fixes the upper segment by contact with the acetabulum, and then closes the opening in the bone. D. Replacement of the limb after union is completed elevates the neck to its former position. (Whitman.)

here is the more scientific course, but on account of its greater simplicity, and for the reasons given above, I recommend sub-trochanteric osteotomy. I shall mention two methods, both of which give good results. I prefer the first as rather the simpler.

I. Cuneiform Sub-trochanteric Osteotomy. Here a wedge is removed below the great trochanter, the apex being inwards and forming a hinge; on this, when the cut surfaces of the bone are brought into contact by abducting the limb, not only is the position

of the limb rectified but the restoration of a more normal angle and direction of the neck is commenced, the after-treatment continuing this object.

R. Whitman's method (*Ann. of Surg.*, 1900, vol. i. p. 145, and *Med. Rec.*, Mar. 19, 1904) will be found comparatively easy and efficient (Fig. 374). It is especially indicated in adolescents (about twelve to seventeen years of age).^{*} In Dr. Whitman's words: "The base of the wedge should be about three-quarters of an inch in breadth, directly opposite to the trochanter minor; the upper section should be practically at a right angle with the shaft, the lower one being more oblique. The cortical substance on the inner aspect of the bone should not be divided, but, reinforced by the cartilaginous trochanter minor, should serve as a hinge on which the shaft of the femur is gently forced out until the opening is closed by the apposition of the fragments after the upper segment has been fixed by contact with the margin of the acetabulum; thus the continuity of the bone is preserved. The leg is then held in the attitude of extreme abduction by a plaster spica bandage, which should include the foot also, until the union is firm."

Here also any contracted adductors or hamstrings must be rectified, either at the time, or beforehand by manipulation or tenotomy.

II. Mr. Watson Cheyne, C.B., divides the femur below the trochanters, and, having rotated the limb inwards until in the position of extreme internal rotation, holds the fragments together by perforated aluminium plates secured with tin-tacks.

When both limbs require operation, they should, if possible, be dealt with at the same time. In a young adult the time required for adequate rest and after exercises, if the result is to be satisfactory, is considerable. Mr. Watson Cheyne gives another reason which affects younger patients. In a case seen some years after the operation, the limb operated on was found to be a good deal longer than its fellow, which, not rectified and still incapacitated, had not grown so well.

^{*} In children Mr. Barnard finds it possible to produce a subcutaneous rectification of the neck of the femur by simply abducting the femur under an anæsthetic, to a similar degree to the normal side and then putting the limb up in plaster (*Clin. Journ.*, Jan. 6, 1904).

CHAPTER III.

OPERATIONS ON THE THIGH.

LIGATURE OF THE COMMON FEMORAL.—TREATMENT OF WOUNDS OF THE FEMORAL OR OTHER LARGE VESSELS BY SUTURE AND RESECTION.—LIGATURE OF THE SUPERFICIAL FEMORAL IN SCARPA'S TRIANGLE.—LIGATURE OF THE SUPERFICIAL FEMORAL IN HUNTER'S CANAL.—PUNCTURED AND STAB WOUND IN MID-THIGH.—AMPUTATION THROUGH THE THIGH.—AMPUTATION IMMEDIATELY ABOVE THE KNEE-JOINT.—REMOVAL OF EXOSTOSIS FROM NEAR THE ADDUCTOR TUBERCLE.—FRACTURES OF THE FEMUR.

LIGATURE OF THE COMMON FEMORAL.

THOUGH this operation is not regarded with much favour, especially for aneurysm, it will be described here, as the question of tying it arises from time to time, and as it should always be performed, for the sake of practice, on the dead body.

Indications.

1. Wounds.—These are rare, here, compared with those affecting the vessels lower down. The wound must always be explored and the bleeding-point sought, for two reasons—(a) Ligature of the external iliac will usually fail to arrest bleeding from the common femoral. (b) The source of the bleeding may easily be mistaken here; thus, Mr. Liston,* in a case of pistol-shot wound of the groin, tied the external iliac for what was proved, at the necropsy, to be a wound of “one of the superficial branches of the common femoral, about half an inch below Poupart's ligament.”

The very important subject of ligature of the femoral artery or vein, or both, in cases of wounds, will be referred to here, though briefly. Such cases will arise most frequently in removal of growths—*e.g.*, epitheliomata, lymphomata, sarcomata—less often in cases of

* *Med.-Chir. Trans.*, vol. xxix., p. 107. The flow of the blood here is said to have been “most impetuous and profuse.” In Mr. Liston's words: “The division of even a small branch close to the principal vessel, it is well known, pours out blood furiously, as much so, in fact, as if an opening in the coats of the artery itself were, so to say, punched out, corresponding in size to the area of the branch.”

stabs. Much interesting information on these subjects will be found in papers by M. Kirrison* (*Rev. de Chir.*, May 10, 1886), and Dr. L. Pilcher (*Ann. of Surg.*, Feb. 1886).

2. Removal of Growths from Scarpa's Triangle and Injury to Femoral Vessels.—M. Kirrison has drawn attention to the following points: In the course of the deeper dissection the pulsation of the femoral artery should be frequently felt for with the finger. As this vessel may have been displaced, it is not enough to trust to anatomical knowledge alone. Where the adhesions are very firm, and where a large growth surrounds the sheath, it is useful to divide the growth and to remove large parts of it, only preserving that part in intimate connection with the vessels, this being finally separated most carefully. In the case of growths in intimate connection with the sheath the vein is particularly in danger, because (a) the vein-walls are much more quickly invaded than the arterial, and (b) the vein is in closer connection with the glands. Two conditions are likely to be met with by the surgeon: 1. Denudation of the vessels. Here the adhesions are sufficiently loose to be separated, and the sheath is either left intact or opened. Every effort must be taken to keep the wound here aseptic. 2. Resection and ligature of one or other of the femoral vessels. If the vein alone has been injured in an operation or by a stab, it should be secured if possible by a laterally applied suture, by resection and end-to-end suture by Murphy's method (p. 917), or by the application of Spencer Wells's forceps left *in situ* for two or three days.† All of these formerly hazardous procedures have been rendered much safer by the precautions of aseptic surgery. Maubrac (*Arch. Gén. de Méd.*, 1889) strongly advocates lateral suture, especially when the lesion is small. Kammerer (*New York Med. Journ.*, 1890, vol. i. p. 511) points out that suture of the wall has undoubted advantages, and that it has been used successfully in the case of the femoral vein by Schede (*Arch. f. klin. Chir.*, Bd. xxviii. S. 671), and (Lange (*New York Med. Jour.*, vol. xlv. p. 720). If these steps are impossible, or fail, the femoral vein must be ligatured. Dr. Pilcher, quoting from a paper of Braun's (*Arch. f. klin. Chir.*, Bd. xxviii. Heft. 3, S. 610), shows that of eighteen cases in which ligature of the femoral vein alone was practised at the level of Poupart's ligament, thirteen occurred as the result of wounds inflicted during the removal of growths. In none of these thirteen cases did gangrene ensue. Dr. Pilcher points out that this is due to the gradual enlargement of the collateral venous circulation which takes place during the increase of the growth. This constitutes a most important difference between wounds of the vein during operation and by a stab. Thus, in five cases in which, as the result of acute injuries, the femoral vein was tied high up, recovery without disturbance took place in only one. In two, death took place

* I am indebted for my knowledge of this paper to an abstract by Mr. T. Jones, of Manchester (*Med. Chron.*, September 1886, p. 514).

† Pilcher mentions a case of Küster's, in which a wound in the vein was secured with hæmostatic forceps; the removal of these after only twenty-four hours was followed by renewed bleeding, ligature of the femoral artery, and fatal gangrene. A case under the care of Mr. Taylor, of Dublin, in which forceps were successfully employed to command the subclavian artery will be found referred to (vol. i. p. 784).

from septicæmia and pyæmia; in the remaining two, gangrene rapidly supervened. Niebergall found that in sixteen cases when both common femoral vessels were tied during the removal of growths about 62 per cent. developed gangrene, and that in eight cases in which both were tied for injury gangrene followed in 50 per cent. On the other hand, in none of twenty-five cases in which the common femoral vein was tied during removal of growths did gangrene occur, and in ten cases of injury in which the vein only was ligatured one only was followed by gangrene. In the case of stab-wounds of the common femoral vessels the complication of infection has to be remembered.

Thus, Mr. Gould (*Med. Soc. Proc.*, vol. x, p. 177) published a case of great interest in which the common femoral vein was wounded ("the whole anterior segment of the vessel" being severed) with a cat's-meat knife. A ligature tied round the vein above and below the wound not arresting the bleeding, the internal saphena which entered the femoral just opposite the wound was tied also. Blood still welled up from the wounded vessel, and further search showed that another vein entered the femoral trunk just opposite the wound in the trunk between the two ligatures. This vein was tied and then all hæmorrhage was found to be arrested. Though the wound was very thoroughly irrigated with solution of hydr. perch. (1-2000), all the infective material introduced by the knife could not be removed. Phlebitis followed, with inflammation of the coats of the artery and hæmorrhage on the ninth day necessitating ligature of the superficial and deep femoral arteries. Meanwhile the infective thrombus had been spreading up the iliac vein until all the chief channels for the return of venous blood were blocked. This brought about moist gangrene, the patient dying on the eleventh day with septicæmia, accelerated by the loss of arterial blood.

The question has been raised whether, when ligature of the common femoral vein has been found needful, the common femoral artery should not be tied also, in order to diminish the risk of gangrene. Dr. Pilcher, while quoting the cases of Roux, Linhart, and Langenbeck, in which this step was successful, shows that the practice of ligature of the common femoral artery as a prophylactic step after wound of the common femoral vein high up, whether in the removal of tumours or injuries—*e.g.*, stabs—is to be discouraged.*

In cases where both vein and artery are wounded these must be secured *in situ* by one of the methods given above. The risk of gangrene is now enormously increased, though the risk will vary somewhat according as the simultaneous ligature or sutures are placed above or below the deep femoral.

A few other points bearing upon the removal of growths here may be alluded to. The internal saphena vein should be carefully preserved intact, and where it is really needful to divide it this should be done as far from the main femoral trunk as possible, otherwise most troublesome œdema may subsequently develop.

In operating close to Poupart's ligament, and especially on the inner side, the presence of the peritonæum, and the possible existence of a femoral hernia, must be remembered.

3. Ulceration into the Artery by Growths.—From the frequency of growths here this indication will occasionally arise. I have met with one case. A man was admitted under my care who had been operated on elsewhere for the removal of sarcomatous glands in the

* In support of this, Dr. Pilcher writes: "To diminish, to an extreme degree, the arterial supply to a part whose nutrition is already seriously compromised by general venous stasis, would certainly tend to precipitate and aggravate the threatened necrosis." The cases collected by Niebergall, alluded to above, emphasise the importance of arterial pressure in keeping up the circulation through the collateral veins.

groin. The application of zinc chloride paste had led to detachment of sloughs and exposure of the common femoral, which gave way, leading to profuse hæmorrhage. I tied the common femoral immediately above the bleeding-point; this was slowly followed by typical dry gangrene, necessitating amputation through the lower third of the thigh.

4. Ulceration of the Femoral Vessels in Inguinal Bubo.—Mr. Shield has drawn attention to this most dangerous condition (*Med. Soc. Proc.*, vol. x. p. 261). Though in his case ulceration occurred in the *superficial* femoral vessels, I have alluded to it here, in association with the previous two headings. Owing to hæmorrhage from sloughing sinuses in Scarpa's triangle, Mr. Shield was obliged to tie both artery and vein, using two ligatures in each case. There was no return of hæmorrhage, and gangrene did not occur, but the patient sank exhausted on the eleventh day with a large pyæmic abscess in the opposite hip-joint. Mr. Shield points out that in these most dangerous cases of spreading sloughing bubo, preventive treatment—use of the sharp-spoon, chloride of zinc paste, continuous warm baths, &c.—is urgently indicated. When once bleeding has occurred and recurred, as pressure,* owing to the condition of the soft parts, is likely to fail, a free incision and ligature of the vessels above and below the point of ulceration is the wisest course.

5. Aneurysm.—There has been much difference of opinion as to whether it is wiser, when dealing with an aneurysm of the superficial femoral high up, to tie the common femoral or the external iliac. English surgeons have rejected ligature of the common femoral for these reasons—(1) The risk of gangrene, as the ligature is placed above both the great nutrient arteries of the limb. (2) The probability of firm clotting taking place after the ligature is rendered doubtful, owing to the number of small vessels given off here—viz., the superficial epigastric, and circumflex iliac, the superior and inferior external pudic, and very commonly one of the circumflex arteries, and also by the proximity of the profunda. (3) The uncertainty of the origin of the profunda, and thus of the length of the common femoral. (4) I would add to the above that ligature of the common femoral for aneurysm approximates the treatment to that of Anel rather than to that of Hunter. Sir J. E. Erichsen (*Surgery*, vol. ii. p. 244), went so far as to say, "It may be laid down as a rule in surgery, that in all those cases of aneurysm which are situated above the middle of the thigh, in which compression has failed and sufficient space does not intervene between the origin of the deep femoral and the upper part of the sac for the application of a ligature to the superficial femoral, the external iliac should be tied."

The opposite opinion has been held by some of the Irish surgeons—viz., the two Porters, Mr. Smyly, Mr. Butcher, and Dr. Macnamara. The last-mentioned surgeon has published† eight cases, of which six were successful, two dying of hæmorrhage.

It is probable, however, that, for the reasons given above, ligature of the external iliac will be preferred, especially as, nowadays, antiseptic precautions and improved ligatures will have rendered this operation increasingly safe.

* At the debate on Mr. Shield's paper, Mr. Cripps supported pressure in these cases. It should be applied methodically according to Mr. Cripps's plan (*vide infra*, p. 926), and, to secure asepsis in these most persistently foul cases, it would be well to try the application of pure carbolic acid, formalin, and, where these are not at hand, that powerful styptic and disinfectant, turpentine (vol. i. p. 745).

† *Brit. Med. Journ.*, October 5, 1867. Mr. G. H. Porter (*Dub. Journ. Med. Sci.*, vol. xxx. N. S. 1860, p. 302) reports three cases, and alludes to two under his father's care. All were successful, though secondary hæmorrhage occurred in two.

6. As a Preparatory Step to Amputation at the Hip-joint.—The need of this has been largely done away with by the adoption of other preferable steps (p. 875).

LINE AND GUIDE.—From a point midway between the anterior superior spine of the ilium and symphysis pubis to the adductor tubercle, and the inner margin of the internal condyle.

RELATIONS :

IN FRONT.

Skin ; fasciæ ; lymphatic glands.

Crural branch of genito-crural. Sheath.

OUTSIDE.

Anterior crural.

Common femoral.

INSIDE.

Septum of sheath.

Femoral vein.

BEHIND.

Sheath.

Psoas.

It is important to note that the common femoral is usually only an inch and a half long, and that from it come off not only the superficial epigastric, circumflex iliac, and superior and inferior external pudic, but occasionally one of the circumflex arteries as well.

Collateral Circulation (Fig. 378).

ABOVE.

Glutæal and sciatic,

with

BELOW.

Superior perforating and circumflex arteries.

Superficial circumflex iliac,

with

Ascending branch of external circumflex.

Obturator,

with

Internal circumflex.

Comes nervi ischiadici,

with

Perforating of profunda and articular of popliteal.

Operation.—The groin having been shaved and cleansed, the hip and knee semiflexed, and the limb abducted and rotated somewhat outwards, an incision about two and a half inches long is made in the line of the artery, commencing just above Poupart's ligament. The skin and superficial fascia having been divided, and any overlying glands displaced or removed, any veins which may be met with descending to join the internal saphena are either drawn aside or tied between double ligatures. The fascia lata having been opened just below Poupart's ligament, the artery or its pulsation is felt for, the vessel exposed here, and the needle passed from within outwards, care being taken to avoid the crural branch of the genito-crural nerve, which lies superficial to the artery. The neighbourhood of any branch is, if possible, avoided. The wound is then most carefully dried out and closed.

SUTURE OF WOUNDS OF LARGE VESSELS.

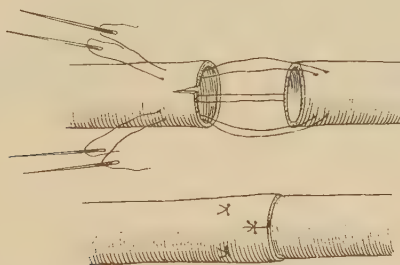
This method, adapted to many wounds elsewhere (*e.g.*, vol. i. p. 343), is referred to here,* because it was in this region that the illustrious surgeon who has advocated it first proved its feasibility.

* While this subject has been dealt with here as it was in the case of the femoral vessels that Dr. Murphy proved the value of his experimental work, the method of suture,

Dr. J. B. Murphy, of Chicago, drew attention to the feasibility of resection and end-to-end suture of arteries and veins (*New York Med. Rec.*, Jan. 16, 1897). *Technique*.—The points to be considered are: (1) Complete asepsis; (2) exposure of the vessel with as little injury as possible; (3) temporary suppression of the blood current; (4) control of the vessel while the suture is applied; (5) accurate approximation of the walls; (6) perfect hæmostasis by pressure after the clamps are taken off; and (7) "toilet" of the wound. Some of the above are considered in detail. Thus for control of the hæmorrhage forceps with broad blades, covered with tubing and a graduated catch, are preferred. They are closed just sufficiently to control the hæmorrhage, and hold the vessel in the correct position for approximation.* If such an instrument is not at hand, a stout silk ligature may be used; it must not be tied so tightly as to injure the intima, and is best secured with a loop-knot, so as to be readily removed.

Ordinary fixation-forceps should never be applied to the vessel itself,

FIG. 375.



Murphy's method of invagination of artery. Insertion of sutures.

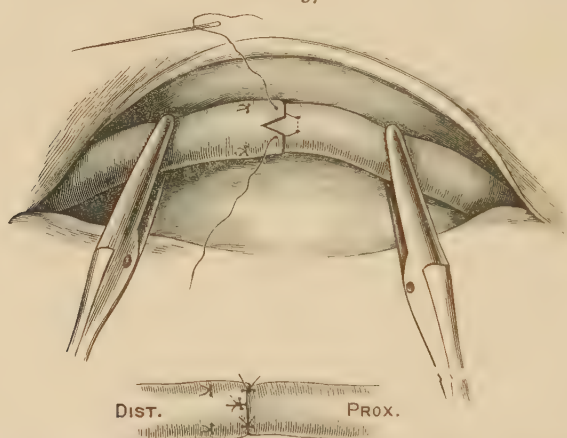
only to the adventitia. The intima should be especially avoided. The most useful needles are the fully-curved sharp and round conjunctiva needles, but ordinary fine cambric needles, if with a large eye, may be employed. The most serviceable suture is silk. The sutures, interrupted, should be inserted about every one-twentieth of an inch, entering one-sixteenth of an inch from the edge of the wound, and should not

with or without resection, of large blood vessels will arise elsewhere, *e.g.*, in the case of wounds of the axillary vessels in operations for carcinoma, especially where much scar tissue is present, and sufficient exposure is difficult and inadequate. Injuries to the common femoral vessels already alluded to (p. 913) are another instance; in fact Dr. Murphy's results and method must now be followed in every case of injury to large vessels where the surgeon's surroundings are favourable, and where the injured vessel can be commanded. The following papers should be referred to: "Injuries to the Axillary Vessels during Operations," by Dr. R. R. Smith, of Michigan (*Ann. of Surg.*, May, 1904, p. 757), and Dr. Halstead (*Med. Rec.*, 1901, p. 81); and "An Experimental Study of Suture of Arteries" by Dr. G. M. Dorrance, of Philadelphia (*Ann. of Surg.*, Sept., 1906, p. 409), a carefully detailed and candid record of valuable experimental work. In the same periodical for July, 1904, p. 107, Dr. G. Torrance records a case of secondary hæmorrhage from the brachial artery, a week after an injury successfully dealt with by a purse-string suture of the vessel, protected by a muscle-graft.

* Such forceps have been introduced by Crile (vol. i. p. 763).

include the intima, on account of the risk of endarteritis and thrombosis. If one-half or more of the artery be wounded, the first suture should be placed in the middle, then one at each angle. When all the sutures have been tied—the tying should not be too tight—the compression forceps are removed, and first from the distal end. If there should be hæmorrhage from the needle punctures compression with the fingers or gauze will be sufficient to control it, as a small thrombus forms in each puncture.* When it is possible, support should be given by suturing over the line of approximation the sheath of the vessel, or some muscular or fascial tissue. The field of the operation should be thoroughly cleansed and drained by gauze, this being removed in forty-eight hours. In bullet wounds the bullet should be removed, as it might be a source of infection. Dr. Murphy has found that when more than

FIG. 376.



Murphy's method of invagination of artery. Insertion of external sutures.
Completion of invagination.

half the vessel is destroyed, it was not advisable to suture the vessel end-to-end, but to make a resection of the injured portion and to produce an end-to-end union by invagination. The sutures are introduced as shown in Fig. 375; two or three double-needed threads are inserted into the end of the proximal portion, including only the two outer coats; these are reinserted at regular intervals one-third to one-half inch above the end into the distal part from within outwards; the threads

* Dr. Brewer, of New York (*Ann. of Surg.*, 1904, ii. p. 857), mentions two cases of suture of large vessels, one of which bears on the point just mentioned. Here the external iliac artery had been injured by a large Hagedorn's needle. The wound was about one quarter of an inch in length. The hæmorrhage being arrested by proximal pressure and the wound freely exposed, the edges of the wound were satisfactorily brought together by two or three sutures of fine silk including all the coats save the intima. As soon as the full force of the circulation was restored the stitches began to cut through, and, in a few moments, the wound was entirely reopened. A second attempt was made with sutures including more of the wall, reinforced by drawing some areolar tissue over them, but the result was the same. The artery was accordingly tied and no untoward results followed. In the second case, where the axillary artery had been injured by another surgeon, Dr. Brewer successfully sutured the wound, which was nearly half an inch long.

are then tied, and this invaginates the artery. In order to facilitate the invagination, a small incision is made parallel to its long axis, extending from one-fourth to one-third of an inch. Next four or five interrupted sutures are inserted into the intussusciptions, binding it to the surface of the intussusceptum, the sutures in the latter entering only the tunica adventitia and media. By this method (Fig. 376) a large surface contact of vessel is secured, the proximal portion being inserted into the distal. Dr. Murphy considers that this method of suturing vessels is indicated not only in injuries but also in aneurysms* of large vessels.

In the first class of cases, *i.e.*, injuries to large vessels in operation, the injury, if less than two-thirds of the circumference be involved, should be immediately repaired by suture. If more than two-thirds be injured, the division should be made complete, and the invagination method used, with the precautions already given. The edges of the wound should, if necessary, be cut clean before the sutures are inserted.

In traumatic aneurysms, recent and old, the opening in the artery is usually small and a sufficient quantity of aneurysmal stump may be retained to produce a firm line of approximation. The aneurysmal sac should be freely opened and enucleated down to the position of the opening. The edges of this should be refreshed and closed, the same technique being observed as in primary suture.

In the fourth class of cases, *i.e.*, sacculated, fusiform and arterio-venous aneurysms, the aneurysmal sac should be exposed and dissected down to the position of the healthy coats of the artery, where it should be amputated, leaving sufficient of the aneurysmal coat and arterial wall to allow a row of sutures involving one-sixteenth of an inch of the margin on either side.

The paper is accompanied by the account of numerous experiments, and two brilliantly successful cases. The evidence thus acquired has led Dr. Murphy to believe that the risk of thrombosis is greatly exaggerated, and that as the resisting power of the walls at the point of invagination is above normal, the danger of rupture and dilatation as well as that of thrombosis is lessened, as while the diameter of the vessel at that point is smaller, the current is more rapid. He admits that after suture there is a tendency to endarteritis obliterans. But this process is a slow one, and while it is occluding the vessel, collateral circulation is being established.

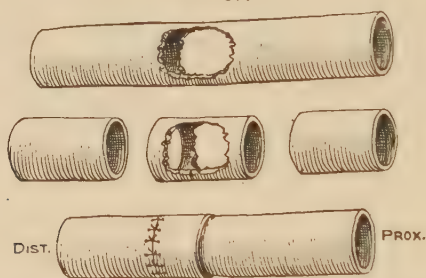
The following are abstracts of the two cases :—

Case 1.—A man, æt. 33, was wounded by a bullet in the left Scarpa's triangle. From the profuse hæmorrhage, the presence of a large swelling without pulsation or bruit, and the

* Dr. Matas (*Trans. Amer. Surg. Assoc.*, vol. xx. p. 416) thus criticises Dr. Murphy's proposals for dealing with aneurysms and compares them with his own, the details of which are given below (p. 981). "Murphy's suggested operation is practically an extirpation of the sac, and as such is fraught with all the difficulties of this operation with the added difficulty of suturing the openings in the vessel itself. He has also overlooked the fact that in fusiform aneurysms the continuity of the main artery is lost for a considerable distance in the sac, where it merges completely with the aneurysmal walls; hence the impracticability of resecting the sac by the method he suggests. In the saciform and arterio-venous aneurysm his procedure is perfectly feasible, but the same result can be accomplished by the much easier and safer plan described in this contribution." Dr. Bicknell, of New York, discusses the application of the Matas method to arterio-venous aneurysms (*Ann. of Surg.*, May, 1904, p. 767).

fact that the left posterior tibial artery pulsated naturally it was believed that the femoral vein, and not the artery, was injured. A free incision parallel with the artery showed that the bullet had first passed through the internal saphenous vein. The two openings on its anterior and posterior surfaces were closed with continuous silk sutures. The dissection being continued, a similar perforation was found in the femoral vein a little above the junction of the profunda. Much difficulty was met with in controlling the hæmorrhage, as the blood returned through the profunda vein when the clamps were placed upon the femoral vein above and below the opening. As it was found impossible to close the posterior opening without dividing the profunda vein, this was done between two ligatures. It now being possible to turn the posterior opening forward, this, like the anterior opening, was closed with a continuous silk suture. After the removal of the clamps a little blood escaped from the postero-inferior angle of the wound in the vein; this was arrested by an additional suture. The femoral artery had a fragment of tissue torn off from the side of its sheath, but the vessel wall was not injured. The wound was sponged out with a 5 per cent. solution of carbolic acid and closed without drainage. Owing to infection by the bullet, the wound suppurated. It was opened and a gauze drain inserted. Suppuration continued about a month after the first operation, and considerable hæmorrhage occurred through a small opening which remained. A large and very tense hæmatoma formed without pulsation. About a month after the first operation,

FIG. 377.



Degree of destruction of artery; portion removed and appearance after invagination in Dr. Murphy's second case.

Dr. Murphy laid the swelling open and turned the clots out; smart arterial hæmorrhage followed, arrested by digital pressure. The inner side of the artery was eroded for one inch, and showed a number of perforations. About one and a half inches of the vessel were resected and a single ligature placed on the distal and a double one on the proximal end. Some fragments of the femur broken off by the bullet were removed. The femoral vein could not be located. The patient made a complete recovery.

Case 2.—A man, æt. 29, received a bullet wound about one and a half inches below Poupart's ligament. About a fortnight later a loud bruit and thrill were apparent at this spot. No mention is made of primary hæmorrhage. The artery was exposed by a five-inch incision, and a provisional ligature thrown round it. Compression-clamps were carefully applied above and below the point of injury to the artery; on elevating the artery profuse hæmorrhage took place from the opening in the vein. A cavity about the size of a filbert was found posterior to the artery communicating with its calibre, forming an aneurysmal pocket. A small aneurysmal sac, about the same size, was found on the anterior surface of the artery over the point of perforation. The bullet had passed through the artery leaving only one-eighth of an inch of the wall on the outer side and one-sixteenth on the inner: it had then passed downwards and backwards, making a large hole in the femoral vein in its posterior and outer aspect just above the junction of the profunda vein. The hæmorrhage from the vein was profuse, and controlled first by digital compression, and later by dissecting the vein free above and below the point of injury and placing a temporary ligature on the profunda vein. The opening in the femoral vein was then sutured, but the method employed is not specified. When the clamps were removed, the vein, which had been greatly narrowed at the point of suture, dilated one-third. Attention

was next turned to the artery. Two inches of this were freed from its surroundings; the opening in the artery was three-eighths of an inch in length, one half-inch was resected (Fig. 377), and the proximal end was invaginated into the distal end for one-third of an inch with four double-needed threads, which penetrated all the coats of the artery as shown in Fig. 375. The adventitia was peeled off the invaginated portion for a distance of one-third of an inch, a row of sutures were placed around the edge of the overlapping distal end, the sutures penetrating only the media of the proximal portion; the adventitia was then drawn over the line of union and sutured. Not a drop of blood escaped at the line of suture. Pulsation was immediately restored in the artery below. The sheath and connective tissue around the artery were then approximated at the point of suture with catgut so as to support the wall of the vessel. The wound was closed without drainage. The duration of the operation was about two and a half hours, most of this time being spent in securing the vein. Though the wound suppurated and required drainage, a complete recovery followed.

LIGATURE OF THE SUPERFICIAL FEMORAL IN SCARPA'S TRIANGLE (Figs. 379 and 380).

Indications.

1. Certain Cases of Aneurysm of the Popliteal Artery or the Femoral low down.—Thus the ligature will probably be indicated—(a) where a popliteal aneurysm is rapidly growing, especially when (b) it is on the anterior aspect of the artery instead of behind or at one side of it, as in the former case the knee-joint may become involved after very obscure symptoms; (c) when the aneurysm is fusiform rather than saccular; (d) when it has very thin walls; (e) when it threatens to burst, or when this has already happened, unless other symptoms—*e.g.*, gangrene—call for amputation; (f) if visceral disease—cardiac, renal, hepatic—or an atheromatous condition of the vessels is present, the surgeon must weigh carefully the question of operative interference: I should prefer in most cases a trial of the ligature as likely, with the aid of antiseptic precautions, a modern ligature and primary union, to entail less taxing of the patient's powers. On this point, so difficult of wise decision, I may say that of the seven cases in which I have ligatured the superficial femoral for popliteal aneurysm the only one that ended in failure was that of a man *æt.* 65, with diseased arteries and interstitial nephritis. Owing to the restlessness and want of amenability of the patient I decided against a trial of pressure. The greatest difficulty was met with in keeping the patient still, and gangrene followed, fatal on the fifth day; (g) where a trial of pressure has failed, or is certain to fail from the irritability of the patient. Matas's operation is given at p. 981, and his method and that of Antyllus are compared at p. 988.

2. Wounds.—Nothing need be added here to what is said on the subject at pp. 913 and 917.

3. For Hæmorrhage low down—*e.g.*, after amputation in the middle of the thigh, when other means fail and the wound is nearly united (p. 927). Two other instances are given by Mr. Bryant (*Surgery*, vol. ii. p. 417).

One was "a case of Mr. Bransby Cooper's in which a compound fracture of the leg was complicated with a laceration of the femoral artery. The artery was secured at the seat of injury, and repair went on well in all respects. Mr. Bransby Cooper has also recorded in his *Surgical Essays* a case of fracture of the femur in which the femoral artery was ligatured for a ruptured popliteal artery, and in which recovery took place in six weeks."

Each of such cases must be considered on its own merits, but the above shows what ligature of the femoral artery will do in appropriate cases.

4. For Elephantiasis.—Cases in which the superficial femoral has been tied will be found in the *Lancet* for 1879, vol. i. p. 44; and Ranking's *Abstract* for 1860, vol. ii. p. 193. The subject of ligature of the main artery of a limb for this affection has been considered at p. 3.

LINE.—That above given, p. 916.

GUIDE.—The above line and the inner border of the sartorius at the apex of the triangle.

RELATIONS.—

IN FRONT.

Skin; superficial fascia; glands; crural branch of genito-crural nerve; middle cutaneous and branch of internal cutaneous; fascia lata; sartorius.

OUTSIDE.

Femoral vein (below). Anterior crural nerve, and some of its branches—viz., the nerve to the vastus internus, and long saphenous nerve.

INSIDE.

Femoral vein (above).

BEHIND.

Psoas; pectineus; adductor longus; femoral vein (below); profunda artery and vein; nerves to pectineus.

Collateral Circulation.

ABOVE.

Perforating of profunda,

with

BELOW.

Lower muscular and anastomotic of femoral, articular of popliteal, and anterior tibial recurrent.

External circumflex of profunda,

with

Ditto ditto.

Comes nervi ischiadici,

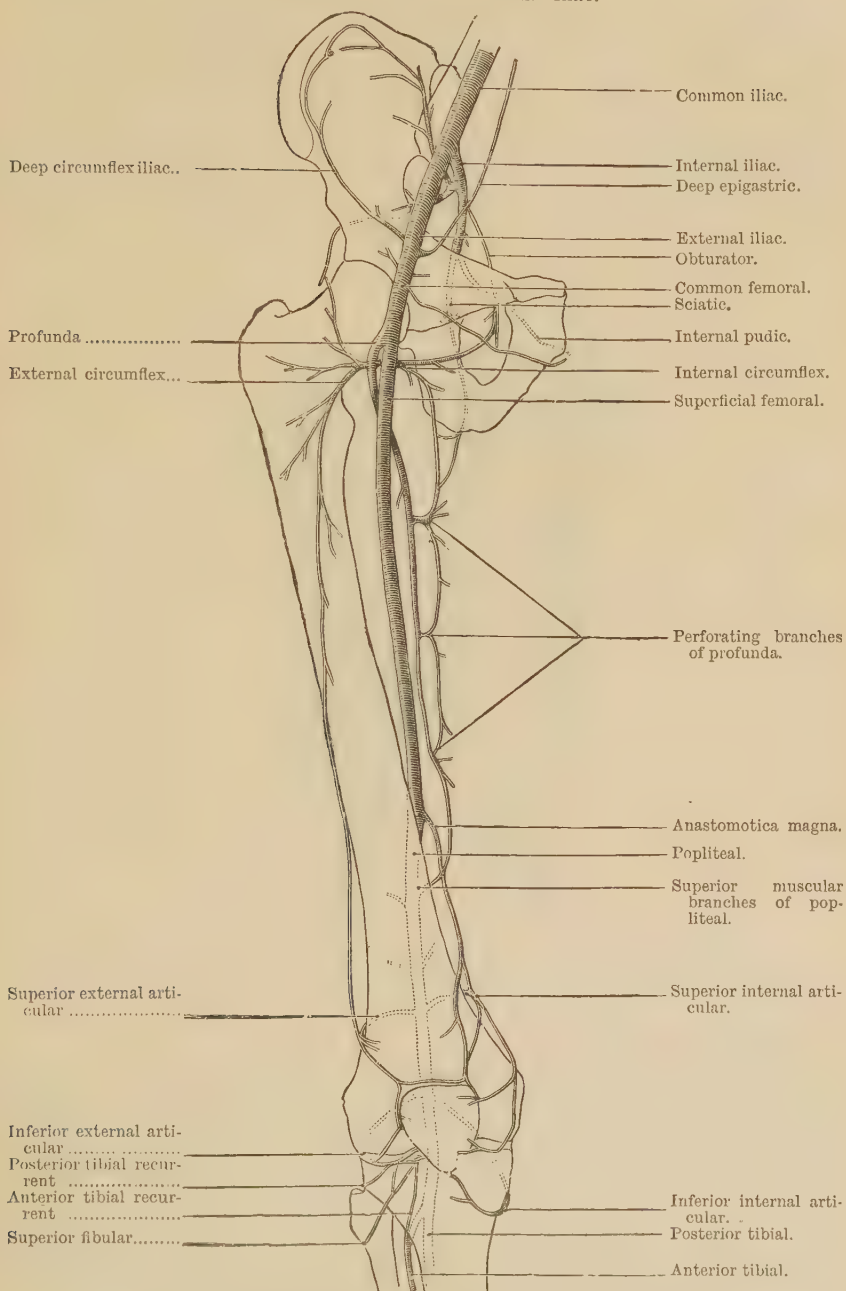
with

Perforating of profunda and articular of popliteal.

Operation.—(Figs. 379, 380).—The parts having been sterilised, the knee and hip slightly flexed, the thigh abducted and somewhat everted, and the leg resting on a pillow, the surgeon, seated or standing to the right of the affected limb, makes an incision three inches long in the line of the artery (p. 916). This should begin about two inches and a half below Poupart's ligament, and run down to, and somewhat below, the apex of Scarpa's triangle, which lies usually four to five inches below Poupart's ligament. The skin and superficial fascia having been divided, any small vessels are secured, and branches of the saphena vein drawn aside with a strabismus hook or secured with double ligatures. The deep fascia is now slit up for the whole length

FIG. 378.

Ilio-lumbar branch of internal iliac.

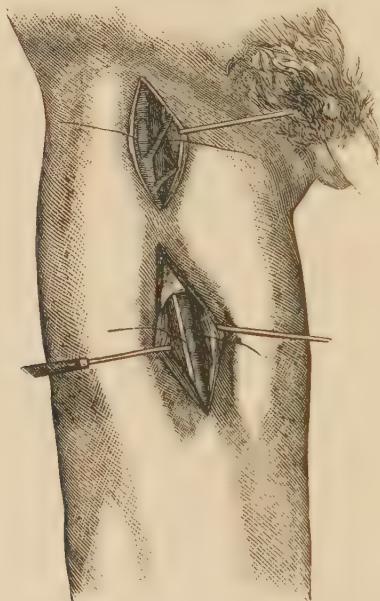


Anastomotic circulation of the iliac and femoral arteries. (MacCormac.)

of the wound, and the inner margin of the sartorius, which crosses the lower part of the incision, identified. This is then held outwards,

while the artery or its pulsation is felt for. The wound being now well opened out with retractors and carefully wiped out, the sheath is opened to the outer side, care being taken to avoid the nerves in contact with it—viz., the long saphenous, and the nerve to the vastus internus. The artery having been cleaned, thoroughly but most carefully, on either side and behind, the needle is passed from within outwards, being kept very close to the vessel so as to avoid the vein which lies behind and internally.* The artery having been tied, the ligature is cut short, drainage provided according to the amount of disturbance of the parts, &c. and the wound closed. The precautions given at p. 7 for the prevention of gangrene must be taken.

FIG. 379.



Ligature of the common femoral, and the superficial femoral at the apex of Scarpa's triangle. The ligature in each case has been passed from within outwards. (Sédillot.)

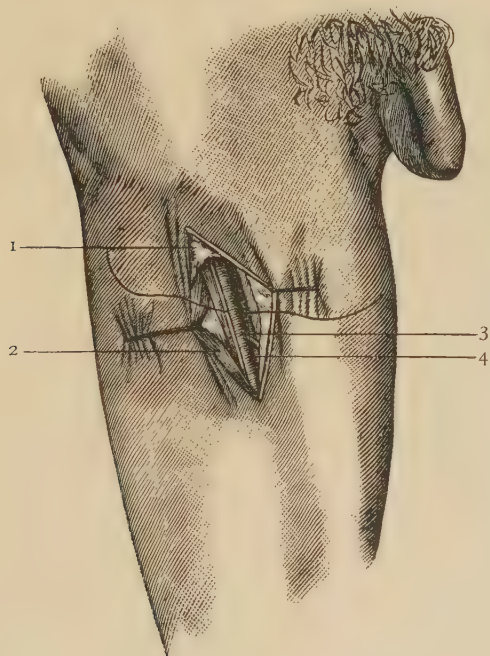
Difficulties and Mistakes.

1. Wounding the Saphena Vein.—This may occur if the incision is made too internal. It is always to be avoided if possible, owing to the

* The vein is so frequently damaged here, especially on the dead subject, that a few precautions may be given as to the best way of avoiding it. First, the sheath must be identified exactly, and sufficiently opened at its outer part. It will be found of much help in cleaning the vessel if one edge of the cut sheath is held by an assistant, while the surgeon has hold of the other; the opening in the sheath is thus made sure of and retained. There must be no needless disturbance, or lifting up of the vessel upon the needle, which, with the director, must be used with the utmost carefulness. As soon as the eye (and this should be at the very end of the needle) is seen to have passed round the vessel the ligature should be at once seized, and the needle withdrawn. On the dead body the apparent thickness due to the solid thrombosis in the vein, in subjects prepared with formalin, must not lead, here or elsewhere, to this vessel being mistaken for the artery.

troublesome œdema which may follow. 2. A very broad Sartorius. 3. Injury to the Femoral Vein.—This may easily take place if force is used in pushing the needle round an imperfectly cleaned artery, or if the needle is not kept close to the vessel. If the accident occur, the surgeon must not persist in his attempt to tie the artery at this spot, a course which will only end in his inflicting more injury in the vein, but finger-pressure being made in the lower angle of the wound, the artery is tied either above or below the spot where the vein has been injured. As soon as the artery is secured, no further hæmorrhage will take place,

FIG. 380.



Dissection of parts concerned in ligature of the femoral artery at the apex of Scarpa's triangle. 1. Fasciæ. 2. Sartorius. 3 and 4. Superficial femoral artery and vein.

but pressure may be kept up by means of sterilised dressings over the wound for a day or two.* The patient will do well to wear a Martin's bandage or an elastic stocking for some time after getting up. 4. Including one of the nerves. 5. A matted condition of the parts due to a previous trial of compression.

Abnormalities of the Femoral Artery.

1. A double superficial femoral, the two trunks uniting below to form the popliteal. More than one case of this kind is recorded. The persistence of pulsation in the aneurysm after the first ligature would lead to a suspicion of this condition. 2. The vessel may run down at the back of the limb.

* If venous hæmorrhage persist, the opening in the vessel should be secured by suture (p. 917), or a pair of Spencer Wells's forceps left *in situ* (p. 913).

LIGATURE OF THE FEMORAL ARTERY IN HUNTER'S CANAL (Fig. 382).—TREATMENT OF A STAB IN MID-THIGH (Fig. 381).

Indications for Ligature of the Femoral Artery in Hunter's Canal.

I. Wounds.—These may be, (a) incised; (b) punctured.

(a) The artery above is controlled by an Esmarch's bandage or the hands of an assistant or provisionally secured by a loop of silk

FIG. 381.



Incised wound of the thigh explored and found to involve the femoral artery.

immediately above the wound in it, or clamps (p. 917) if these are at hand. The wound is then enlarged and the vessel dealt with according to the directions given at p. 917, if possible. Only if the conditions do not admit of this is the artery to be tied above and below the wound in it. If the vein is injured also, suture is still more strongly indicated; if ligatures are applied, the patient or the friends must be prepared for the possibility of imminent need of amputation. Here, as in all cases, where, owing to the hurry, sterilisation of the parts may have been imperfect, a boracic acid fomentation should be applied. The limb should be secured on a splint, and the foot of the bed raised.

(b) If a punctured wound lies in the line of the artery (p. 916), and if much blood has been lost, the main trunk is probably injured, and the question will arise, if the bleeding has ceased, whether to cut down upon the artery or to trust to pressure. Mr. Cripps (*Dict. of Surg.*, vol. i. p. 525) advises that, if the wound be in the upper part of the thigh, "the surgeon may enlarge the wound with a good prospect of finding the wounded vessel without

an extensive or prolonged operation. If the wound be in the lower half of the thigh, owing to the greater depth of the artery and the possibility of its being the popliteal which is wounded, the search is rendered far more severe and hazardous, and it should not be taken until a thorough trial of pressure has proved ineffectual."

The following mode of applying pressure is taken from Mr. Cripps (*loc. supra cit.*)* I would also refer my readers to the account of punctured wound of the palm given at p. 36, Vol. I., of this work.

* Mr. Cripps draws attention to the instructiveness of the literature of this subject, as it proves not only that many cases have been successfully treated by pressure from the

The main vessel having been controlled above, the foot and leg should be carefully strapped from the toes to the knee, and a bandage then carried from the toes up to the wound, and then, avoiding this, up to the groin, where it is secured, spica-fashion, over a pad on the main artery. The limb is then laid on a long back splint with a foot-piece, and secured to this in an elevated position. The wound having been sterilised, a graduated gauze compress is then fastened over it. Two sterilised rectal bougies are then applied in the course of the artery, above and below the wound, outside the bandage which surrounds the limb, so as to keep these segments of vessel empty. Two well-padded lateral splints are then secured with straps and buckles to the thigh. The toes should be left exposed as their condition may be watched. Morphia must be given as freely as is judicious.

2. Hæmorrhage from a Stump after Amputation in the Lower Third of Thigh or Knee.—If clearing away the clots and disinfecting the stump, followed by well-adjusted pressure, and, this failing, trying to find the bleeding point in the flaps, do not suffice, the artery must be tied above.*

LINE AND GUIDE (p. 916).

RELATIONS :

IN FRONT.

Saphena vein.

Skin; fasciæ; sartorius; aponeurosis between vastus internus and adductors.

OUTSIDE.

INSIDE.

Vastus internus; vein (slightly).

Adductor longus and magnus.

Femoral artery in Hunter's canal.

BEHIND.

Femoral vein (especially above).

Operation (Fig. 382).—The knee and hip having been flexed, and the limb abducted and rotated outwards, the surgeon, seated comfortably on the inner side of the limb, makes an incision three inches and a half long in the line of the artery in the middle third of the thigh.† The skin, superficial and deep fasciæ, having been divided, and the saphena vein, if seen, drawn to one side with a strabismus hook, or any of its branches divided between double ligatures, the sartorius is identified by the direction of its fibres and drawn to the inner side. The canal is next opened by dividing the aponeurotic roof, and the artery or its pulsation felt for. The vessel will be found closely

first, but that both life and limb have been saved by pressure after the surgeon has failed to find the artery in the wound, or after the iliac has been tied in vain.

* I would again refer my readers to Mr. Cripps's article (*loc. supra cit.*, p. 526). He points out that a decision between opening the flaps or ligaturing the main vessel high up must depend on the amount of union, and that if the flaps must be opened and the vessel sought for before there is much firm union, as in the first fortnight, a director should be used rather than a knife, and that if the vessel is found, its soft condition will require very gentle tying.

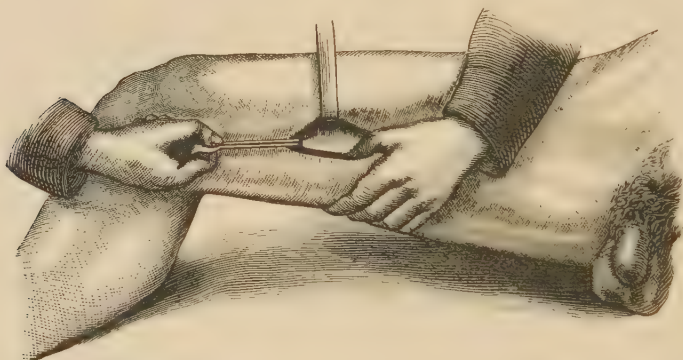
† This incision must not be made too low down. Its centre should correspond to the centre of the thigh.

connected to its vein, which lies behind it, while the saphenous nerve crosses it from without inwards. The artery having been most carefully cleaned all round, the ligature may be passed from either side, as is found most convenient.*

Causes of Failure after Ligature of the Femoral.

1. Gangrene. 2. Secondary Hæmorrhage.—If pressure fail, an attempt must be made to re-tie the vessel, and this not succeeding, the limb must be amputated. 3. Suppuration of the Sac of an Aneurysm.—This is very rare. 4. Recurrent Pulsation in the Aneurysm.—The premature softening of the ligature, especially in an infected wound, must always be remembered as a possible cause of

FIG. 382.



Ligature of the femoral artery in Hunter's canal. The surgeon, here standing outside, finds the furrow between the adductors and the quadriceps, and then makes an incision in the line given at p. 916. The lower lip of the wound having been depressed with the left thumb, the deep fascia is divided on a director. (Farabeuf.)

this. Pressure failing, the artery may be tied lower down. 5. A very rare complication is the formation of an aneurysm at the seat of ligature.

AMPUTATION THROUGH THE THIGH (Figs. 383–386).

Practical Points in Amputation of the Thigh.—The operation should always be performed as low down as possible, not only to avoid shock and to secure as long a stump as possible for the artificial limb, but also to secure as much as possible of the rectus femoris. This muscle

* Much difficulty will be met with in tying the femoral artery in Hunter's canal unless the line of the artery (p. 916) is strictly followed. A common mistake is to make the incision too far out, thus exposing the fibres of the vastus internus, which run downwards and outwards, instead of those of the sartorius, which run downwards and inwards (Smith and Walsham, *Man. of Oper. Surg.*, p. 83). Sir J. E. Erichsen (*Surgery*, vol. ii. p. 250), who gives as the line of the artery, one drawn from a point exactly midway between the anterior superior spine and the symphysis pubis to the most prominent part of the internal condyle, insists on the need of making the incision a finger's-breadth internal to this. The line which I have given above will be found sufficiently internal.

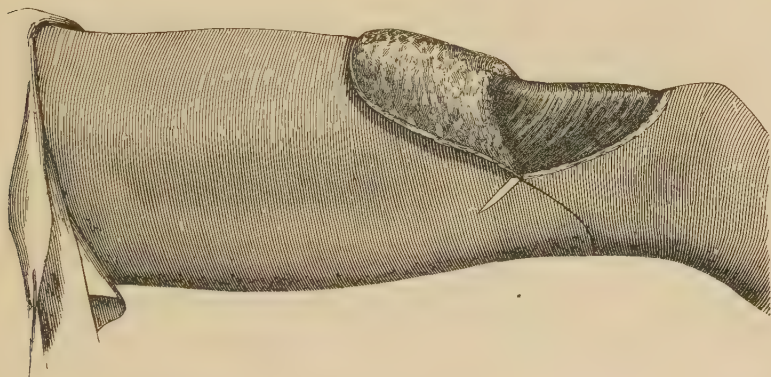
is a most important agent by which the thigh is put forward in stepping. Its division does not preclude the retention of its office, as it acquires a sufficient adhesion to the material of the stump to answer every useful purpose, as an agent in the flexion of the thigh on the pelvis, though that of extension of the leg be destroyed (Skey, *Oper. Surg.*, p. 391).

Different Methods.—The following five, which will give ample choice, will alone be described here; the first is especially recommended:

I. Mixed Antero-posterior Flaps and Circular Division of the Muscles. II. Antero-posterior Flaps by Transfixion. III. The Circular Method. IV. Rectangular Flaps. V. Lateral Flaps.

I. Mixed Antero-posterior Flaps and Circular Division of the Muscles (Fig. 383).—By the term mixed is meant an anterior flap of skin and fasciæ raised from without, and a posterior one made by transfixion. The anterior is, wherever practicable, made the longer of the two.

FIG. 383.



! The knife should have been inserted here from the inner side.

This method has the following great *advantages*: (1) The longer anterior flap falls well over the bone, and thus keeps the scar behind; (2) being raised from without inwards, it can be taken from the neighbourhood of the knee-joint and patella; (3) it is a most expeditious method,* almost as quick as that by double transfixion-flaps; (4) it is suited to all cases, save perhaps those of very muscular thighs, where the surgeon should be careful to take only part of the muscles behind as he transfixes, or else should raise his posterior flap also from without inwards; (5) it gives good drainage.

While amputation by anterior and posterior flaps is given in detail, the surgeon will not tie himself to this method, but use such modifications as that by antero-external and postero-internal flaps. Save in cases of malignant disease, the chief object is to save as much of the femur as possible and also of the adductors. The length of the leverage on the artificial limb is thus increased, and the action of the abductors better counter-balanced.

* As in railway and other accidents.

Operation.—The femoral artery having been controlled with an Esmarch's bandage,* the limb, a sterile towel having been first bandaged on, being brought over the edge of the table, and supported by an assistant; the opposite ankle being tied to the table, and the parts duly cleansed, the surgeon standing to the right side of the limb to be removed, places his left index and thumb on either side of the limb, at the level where he intends to saw the bone,† and sinking the point of his knife through the skin just below the former and rather below the centre of the outer or inner aspect of the limb, as the case may be, carries it rapidly down for about four and a half inches, and then sweeps it across the limb with a broad, not pointed, convexity, and carries it up along the side nearest to him as far as his thumb. A flap of skin and fasciæ, muscle being taken up increasingly towards its base, is then quickly dissected up, and the knife, being sent across the limb, behind the bone, cuts a posterior flap, the knife being used with a rapid sawing movement, and driven at first straight down parallel with the bone, and then sharply brought out through the skin.

The flaps, covered with gauze, being held out of the way by the surgeon's left hand,‡ the soft parts around the femur are next severed with circular sweeps § till the bone is exposed, when one more firm sweep divides the periosteum.||

The saw is now placed with its heel on the bone and drawn towards the operator once or twice with firm pressure so as to make one groove, and one only. With a few sharp sweeps the bone is next severed, care being taken to use the saw lightly for fear of splintering the *linea aspera*, and to use the whole length of the instrument. At this time the limb must be kept steady and straight, the assistant neither raising it, which will lock the saw, nor depressing it, which will splinter the femur when this is partly divided.

If the surgeon decide to make his posterior flap also of skin and fasciæ, he must have the limb raised, and first looking over and then stooping down, he marks out a skin flap about two-thirds the length of the anterior; this is then dissected up, and the operation completed as before.

In addition to the femoral vessels, the anastomotica, and descending branch of the external circumflex, some muscular branches will require attention; and one of these last may give some trouble from its position close to the bone, in contact with the *linea aspera*.

The following points deserve attention in tying the femoral vessels :
(1) Not to include the saphenous nerve; (2) the tendency of the vessels to slip up if the point of their division passes through Hunter's canal; (3) if the vessels are atheromatous, they must not be tied too tightly.

* If the surgeon is amputating very high up, the method given in the account of amputation at the hip-joint (p. 875) may be used.

† The finger and thumb should not be shifted till the anterior flap is marked out.

‡ And also pressed firmly upwards, so as to enable the saw to be applied as high up as possible. If the limb is bulky an assistant must help here.

§ This requires really forcible use of the knife, the muscles behind the bone tending to be pushed before the knife rather than divided by it.

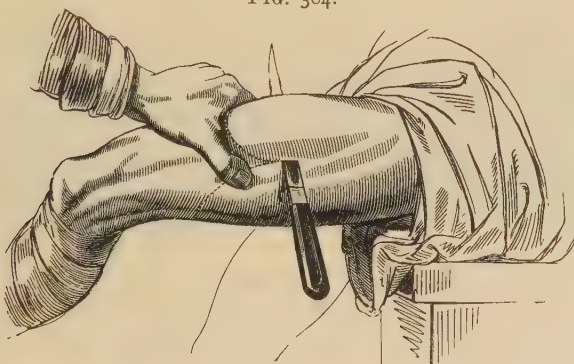
|| This final cut should be a little above the base of the flaps, in order that the sawn femur may lie well buried in soft parts.

A sterilised silk ligature, not too fine, should be employed now, and care should be taken to include a little of the soft parts so as to prevent the ligature cutting through.

In amputations of the thigh accompanied by grave shock (p. 883), no time should be lost in looking for vessels, save the femoral and any other large branch which can be seen. Firm bandaging and raising the stump will suffice. It is well to partially relieve the tightness of the bandages in a few hours by nicking them. Very few sutures should be used in these cases of shock, or in those where the soft parts are sinus-riddled.

II. Transfixion Flaps (Fig. 384).—*Advantage*.—Great rapidity. *Disadvantages*.—Those given at p. 94, Vol. I., on a large scale. This method may be used where much speed is needed, as in a double amputation after a railway accident, or where many wounded require attention, as after a great battle. It is also adapted to the wasted muscles of a patient who has long suffered from some chronic disease of knee or leg, but even here it is inferior to the mixed method.

FIG. 384.



(Fergusson.)

Operation.—The preliminary steps given at p. 930 being taken, the surgeon, standing to the right side of either limb, with his left index and thumb marking the site of his intended bone-section, raises with his hand the soft parts on the front and sides of the thigh, and sends his knife across the limb in front of the femur. The knife should be entered well below, so as to get as large an anterior flap as possible, and at its entry should be pushed a little upwards so as to go easily over the bone. An anterior flap is then cut four to four and a half inches long, with a broadly curving, almost square extremity, and not too thin at its edge. This being raised by the surgeon or an assistant, the knife is now passed behind the bone, and a posterior flap cut of the same length as the anterior, the making of this flap being somewhat facilitated by drawing the soft parts on the back of the limb away from the bone.

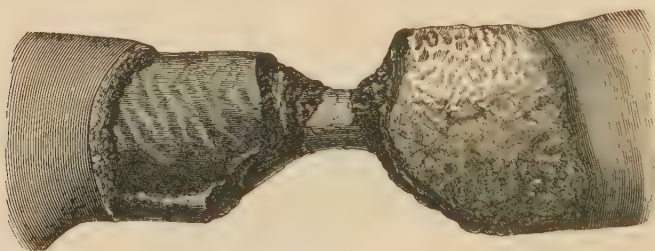
If the limb be very bulky, the knife should be kept well away from the bone, especially behind it, and not as in Fig. 384; thus the more superficial muscles only will be included in the posterior flap.

Both flaps having been retracted, the remaining soft parts are severed with circular sweeps, and the rest of the operation completed, as at

p. 930, but with this difference, that here there will be more need of trimming some of the soft parts clean and square.*

III. **The Circular Method.**—I may here state briefly why this method is, nowadays, considered inferior, both in the thigh and elsewhere, to that by flaps. In saying this, it is not denied that in many cases stumps by the circular method are fully equal to those by flaps; indeed, in many it is impossible to tell, in later years, which method has been employed. On the whole, however, the *flap-method* has the following *advantages*: (1) It is most generally applicable—*e.g.*, in most parts not circular and at the joints.† (2) By it the surgeon can better adapt his skin covering to his needs—*e.g.*, when the skin is less available on one aspect of the limb than on another. (3) There is less risk of a conical stump; and (4) of a cicatrix adherent to the bone. The great advantage of the circular method—*viz.*, that the vessels and nerves are cut square, and that, thus, the former retracting more easily, fewer need securing, while there is less risk of bulbous ends forming on the latter—is attained by

FIG. 385.



Circular amputation of the thigh to show the greater retraction of the muscles behind.

the mixed method of skin flaps and circular division of the muscles as advised at p. 930.‡

The circular method is only to be adopted here in the case of the lower third of wasted thighs, or in those of young subjects. Even here the greater tendency of the posterior muscles to retract (Fig. 385) must be met by cutting them about three-quarters of an inch longer than those in front.

While this operation is for the above reasons not recommended in practice, it may be made use of in the lower third of the thigh in the cases mentioned above. On the dead subject, the student who has not had a chance of performing it upon the arm, may make use of it here.

Operation.—As this method has been described in detail at pp. 98,

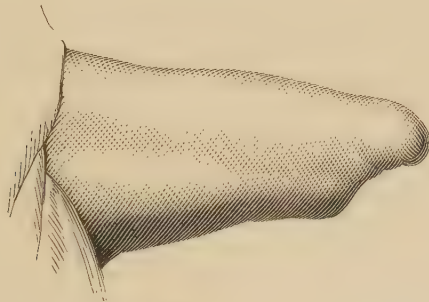
* While dresser to the late Mr. Poland, I once saw the femoral vessels split for about three and a half inches by his rapid hands. This amputation of the thigh by transfixion was his last operation at Guy's Hospital. He was even then facing with quiet braveness the bronchitis which, a very few days later, ended his life.

† To these it may be added that the circular method is not adapted to a case where the skin is matted to the subjacent muscles.

‡ One more advantage of the flap-method is the greater rapidity, especially when transfixion is employed, though this, in these days of anesthetics, is only of importance in a few cases

157, Vol. I.,* it will be only briefly given here. The preliminaries are those already given. The surgeon standing to the right of the limb, the assistant, who stands on the opposite side to him, but nearer the trunk, draws up the skin with both hands. The surgeon, stooping a little, passes his knife first under the limb then above, across, and so around it till by dropping the knife vertically the back of the instrument looks towards him, while its heel rests on that side nearest to him. He then makes a circular sweep around the thigh, this being aided by the assistant who has charge of the limb rotating it so as to make the soft parts meet the knife. The surgeon then taking hold of the edge of the incision, dissects up a cuff-like flap, about four and a half inches in length, cutting it of even thickness all round the limb. The flap is then folded back, and the remaining soft parts divided with circular sweeps of the knife. In doing this the greater contraction of the hamstring muscles must be remembered (Fig. 386), and these muscles cut rather longer

FIG. 386.



Inner aspect of the stump of a left thigh, amputated by the circular method. The powerful tendency of the posterior muscles to retract has not been allowed for, and the stump, in consequence, is conical. (Farabeuf.)

than those in front. Care must be taken, if it is thought needful, after making the circular sweeps, to free the bone higher up, and so to secure its being well buried in the soft parts, but not to prick the already divided femoral vessels which lie in close proximity to the femur in the lower third.

IV. Rectangular Flaps of Mr. Teale.—This method is fully described p. 1003. It is not recommended here, as it is expensive, involving division of the bone nearer to the trunk than other methods. (1) Owing to the bulkiness of the long anterior flap, it is, here, especially difficult to fold and adjust it at the conclusion of the operation, and still more so to keep it adjusted if primary union fails. (2) Its chief advantages—keeping the end of the bone well buried, and cutting the vessels and nerves clean and square—are also sufficiently attained by the other flap methods already given, especially the mixed method (p. 930).

V. Lateral Flaps.—This method has certain grave objections here. (1) The sawn femur, tilted upwards by the ilio-psoas, is very liable to press against the upper angle of

* If it be objected that the plan here given of turning up a cuff-like flap is likely to lead to sloughing, I would reply that this is not so in these days of modern surgery. If sloughing is dreaded, a little more time should be taken in dissecting up a thin layer of muscle, so as to secure the deep fascia and, thus, a better vascular supply.

the flaps, and to come through at this spot, and necrose. (2) If this does not take place, the bone often adheres to the cicatrix here, while the flaps hang down and away from it.

It should only be made use of when no other method is available, as in a case where, owing to the condition of the soft parts, flaps can only be got by making one long external and a short internal, or *vice versd*.

Operation.—This method will be found fully described at p. 1000.

This will be a convenient place for making a few remarks which may be useful to my juniors on certain grave conditions in which amputation through the thigh may be called for. I refer to—A. **Amputation during shock**; B. **Multiple amputations**; and C. **Amputation for gangrene**.

I take first A, the question of the advisability of primary amputation in severe injuries, while shock is present. Each case must be studied by itself according to the conditions present, both as regards the injury and the patient. If a general rule can be formulated it would be to run the risk, inevitably great, and operate as soon as possible. Delay, say for six or twelve hours, will not remove the factor of shock altogether, while it exposes the patient to other dangers. H. Cushing (*Ann. of Surg.*, Sept., 1902) strongly advocates early amputation. "Here a state of shock may already be present, and the attendant ordinarily is advised to wait for some hours, during which time a readjustment of conditions is expected to take place, and the severity of shock to diminish. As a matter of fact, the very conditions are present which tend to perpetuate or to increase the already existent degree of shock. Such an increase is brought about by a continuation of afferent sensory impulses. The tourniquet itself, which has been applied at the time of the accident, although controlling the loss of blood, constantly adds, from pain, to the shock of the original injury. The dragging of the mangled limb on the great sensory nerve trunks, which are rarely severed, gives impulses of pain with every movement of the often restless patient, impulses which in such a state cause reflexly a further lowering of blood pressure. Strychnia, intra-venous infusion, and delay are the usual measures advocated for such states. I believe they are, if not actually harmful, certainly not helpful. The real indication is to rid the patient of the centripetal impulses, originating in the crushed member, by cocaineisation* and division of the large nerves, so often exposed in a mangled limb, by ligation of vessels, and the earliest possible removal of the painful tourniquet. Under proper management, with possible strapping of the abdomen to hold up the blood pressure, with morphia in small amounts to control restlessness, and with a proper avoidance of those conditions which during the operation would increase shock, I believe that it is no heresy to advocate ether anæsthesia (never chloroform) and early operation for most cases of severe traumatism of the extremities."

B. Multiple amputations.—The main points here are:—1. To perform the operations together. Thus when the services of three operators can be secured a triple amputation can be completed in thirty-five minutes. 2. In such a case a large saline infusion should be made into one of the main veins severed during the amputations. 3. As advised by Crile, eucaine should be injected into the main nerve

trunks (Vol. I. p. 226). 4. No time should be lost in tying a number of smaller vessels. The main trunks should be secured, and Spencer Wells's forceps applied to other bleeding points, or the wound packed with gauze and firmly bandaged. Such bandages will need nicking in an hour or two. 5. There should be no close or tight suturing; any attempt to secure primary neatness will only defeat its own end. 6. As sterilisation will probably be incomplete, wet gauze dressings should be applied, to be replaced for the first few days, when the danger of hæmorrhage has passed, by boracic acid fomentations. 7. For the first two days the patient should have a room to himself.

C. Amputation in cases of gangrene.—These may be divided into **acute** and **chronic**. In the former a high amputation is the patient's only chance, as in Mr. C. Heath's case of disarticulation of the shoulder-joint (Vol. I. p. 178). In the lower extremity the resort, though the only one, is much more desperate. Knott (*Journ. Amer. Med. Assoc.*, April 11, 1903) recommends amputation in two stages in acute traumatic cases. A circular amputation is first performed just above the line of apparent demarcation. Later, when the patient's condition is improved, a second operation, which consists in a higher division of the bone and approximation of the soft parts, is done. The reasons for advising this are that the first operation may remove the source of infection, and that the cutting of flaps and introduction of sutures tend to produce gangrene in structures the circulation of which is already bad. Knott has practised the above method four times—once in the upper third of the thigh, once in the middle third of the forearm, and twice in the upper third of the leg—with uniformly good results.*

Amputation in chronic gangrene.—I refer here to cases originating in cardiac disease, frost-bite, typhoid fever, pneumonia, and the more common ones, viz., those simulating the senile form in which, in an elderly patient after an injury, *e.g.*, to the leg, thrombosis begins in a large muscular branch, and creeps up into the tibial arteries, and lastly, and more especially, to senile gangrene. And I use the term "chronic" rather than "dry" because senile gangrene, of which I speak more particularly, is only dry while it remains limited to the toes, owing to the small supply of fluid and the readiness of evaporation. While in many of the other cases of chronic gangrene the

* The following case is of some interest, as it shows that sometimes the worst forms of spreading gangrene may be prevented by an amputation, though the surgeon may not be aware of this at the time. Three years ago, a young man who had been run over on the South Eastern Railway was admitted with the lower part of one leg so smashed as to call for amputation through the upper third. This was done by my house surgeon, Dr. Norman Ticehurst, now of St. Leonards. When I scrutinised the condition of the ligatured vessels, I happened, by the merest chance, to detect some bubbles of gas in the connective tissue between some of the intermuscular septa. Pointing this out as an instance of the far-reaching effects of a very severe injury, I suggested that the tissue affected should be cut out and forwarded in a sterile tube to the Bacteriological Department, and further directed that a drainage-tube should be inserted and very few sutures employed. The flaps sloughed almost in their entirety, and, in a few days, the report reached us that the bacillus of malignant œdema had been present. The patient recovered, and the stump was, ultimately, most serviceable. The soil at the site of the accident was that of the permanent way between London Bridge and Cannon Street Stations.

surgeon will do well to wait because the progress is so slow, and because, owing to the completeness of the dryness, infection and toxæmia are absent, this delay will thus allow of a much less severe amputation and a more useful artificial limb; this is not the case where there is evidence of the gangrene being "mixed." Here evidence of infection may show itself at any moment, and owing to the vitality of the patient, may be rapidly fatal. Sooner or later, senile gangrene reaches the sole, and now becomes moist as well as dry, and the result of infection will speedily follow. For this reason, and because established gangrene of the toes means a bed-ridden patient and a death in life, because the pain and loss of sleep admit of no real alleviation, and, together with the progressive impairment of damaged viscera, will but further lower the depressed vitality to a point unable to safely meet the operation when this, often too late, is consented to—for these reasons I advocate strongly amputation through the lower third of the thigh in senile gangrene as soon as this is established in the toes. I take it for granted that the other factors in the question relating to the patient's general condition are sufficiently favourable. My experience would lead me to look upon diabetes and albuminuria, especially in stout patients with an unstable mental condition, as prohibitive. If a surgeon, early in his experience, be asked about the value of local interference, *e.g.*, detachment of gangrenous parts, incisions, or a low amputation, the results are, as a rule, so extremely bad that such questions should not be entertained. Amputation high up in the leg gives results but little better, owing to the condition of the vessels. Thus of thirteen cases recorded by Heidenhain in only two did the flaps heal, two died of reappearing gangrene, nine were reamputated. In amputation through the lower third of the thigh, the results improve owing to the better nutrition of the parts. Thus of sixteen cases amputated through and above the knee-joint eight recovered and eight died (Heidenhain). G. Bellingham Smith and H. E. Durham found that of eighteen cases of amputation through the thigh ten recovered (in four there was some gangrene and infection of the flaps); eight died. While the step will always remain one of great gravity, one in which both sides of the question must be fairly placed before the patients and the decision left to them, and while it too often proves only palliative owing to reappearance, ultimately, of gangrene in the opposite limb, I consider it abundantly justified in suitable cases for the reasons already given, and I would lay stress on the amputation being through the lower third of the thigh, and here only. The greater distance from the gangrene, the better nutrition of the parts, the vascular muscular tissues, the single large artery easy to secure, all emphasise this point. The chief details to bear in mind are to see that the Esmarch's bandage or its equivalent is put on with great care, to cut the flaps sufficiently long and thick and uniform—and here every cutting instrument should be of the sharpest—not to insert too many or too tight sutures, and to make use of drainage. It is very difficult to make out the condition of the main artery beforehand. If it be thrombosed, an unusual number of small vessels will probably need securing. Where it is rigid and calcareous, the ligature must not be too small, and some of the sheath, and, if needful, some fascial or muscular tissue as well, must be included in it. In two of my cases

in which this condition of the femoral artery was present, uninterrupted healing and recovery followed. In diabetic patients, if of sufficient hardihood to make the trial, local analgesia (Vol. I. p. 652) should certainly be tried.

AMPUTATIONS IMMEDIATELY ABOVE THE KNEE-JOINT (Figs. 387-395).

While conditions admitting of the performance of these amputations are not common, the surgeon should be familiar with them, especially with that of Carden, owing to the importance of preserving as much as possible of the femur and adductors.

Methods.

i. **Carden's** (Figs. 387, 388, 389). ii. **Gritti's Trans-condyloid** (Figs. 390, 392, 393). iii. **Stokes's Supra-condyloid**, an important modification of the above (Figs. 391, 394, 395).

All the above, but especially the two latter, possess the following *advantages* (which they share with amputation through the knee-joint) over amputation through the thigh, viz.:—

1. The patient can bear his weight in walking on the face of his stump; thus, he is not compelled to take his bearing from the tuberosity of the ischium, or to walk as if he had an ankylosed hip-joint (Stokes), as is the case after amputation of the thigh.
2. Very good power of adduction over the artificial limb remains. Every surgeon must have noticed how badly off a patient is in this respect after an ordinary amputation through the thigh. By these methods the adductors are left almost intact, even to part of the strong vertical tendon of the adductor magnus, the result being that the balance between the adductors and the abductors of the thigh remains practically undisturbed, and the patient when walking has none of that difficulty (which is seen after thigh amputations) of bringing the limb which he has swung forwards in again under the centre of gravity.*
3. The medullary canal is not opened: on this account there is less risk of necrosis and osteo-myelitis if the stump becomes infected.
4. There is less shock, because (a) the limb is removed farther from the trunk, (b) the muscles are divided not through their vascular bellies, but through their tendons.

i. **Carden's Amputation** (Figs. 387, 388, and 389).

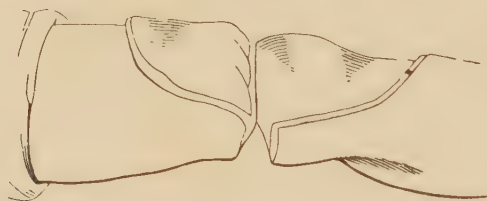
Advantages.—This valuable amputation has some points in common with Syme's amputation at the ankle-joint. In both the bone-section is made not through a medullary canal, but through vascular, quickly-healing cancellous tissue, in both the skin reserved for the face of the stump has been used to pressure, though not equally so, for the skin preserved in the ankle-amputation is thick and callous, in the other thinner and more sensitive.

Lord Lister (*System of Surgery*, vol. iii. p. 705) thus recommends this amputation: "This operation, when contrasted with amputation in the lower third of the thigh, presents a remarkable combination of advantages. It is less serious in its immediate effects upon the system,

* The importance of the preservation of the quadriceps extensor, given by the Stokes-Gritti method, need only be alluded to.

because a considerably smaller quantity of the body is removed, and also because, the limb being divided where it consists of little else than skin, bone, and tendons, fewer blood-vessels are cut than when the knife is carried through the highly vascular muscles of the thigh; the popliteal and one or two articular branches being, as a general rule, all that require attention, so that loss of blood is much diminished. In the further progress of the case the tendency to protrusion of the bone, which often causes inconvenience in an amputation through the thigh, is rendered comparatively slight by the ample extent of the covering provided, and also by the circumstance that the divided hamstrings slip up in their sheaths, so that the posterior muscles have comparatively little power to produce retraction. The superiority of the operation is equally conspicuous as regards the ultimate usefulness of the stump, which, from its great length, has full command of the artificial limb, while its extremity is well calculated for sustaining pressure, both on account of the breadth of the cut surface of the bone divided through the condyles, and from the character of the skin habituated to similar treatment in kneeling. Considering therefore that this procedure can

FIG. 387.



(Carden.)

be substituted for amputation of the thigh in the great majority of cases both of injury and disease formerly supposed to demand it, 'Carden's operation' must be regarded as a great advance in surgery."*

Disadvantages.—The chief of these is the sloughing of the long anterior flap which may occur, "in spite of faultless operating," especially if the skin, of which it chiefly consists, has been damaged by injury or disease, or if the patient be old or weakly, thus leading to an adherent, tender scar, and a useless stump.

Operation.—According to its introducer this amputation consists in removing a rounded flap from the front of the joint (Figs. 387 and 389), dividing everything else straight down to the bone, and sawing this slightly above the plane of the muscles.

The operator, standing on the right side of the limb, takes it, between his left forefinger and thumb, at the spot selected for the base of the flap,† and enters the point of his knife close to his finger, bringing it round through the skin and fat below the patella to the spot pressed by his thumb, then turning the edge downwards at a right angle with the

* Other advantages given by Mr. Carden are, the favourable position of the stump for dressing and drainage; its painlessness, the chief nerves being cut high up and slipping upwards out of the way; and the cicatrix being drawn clear of the point of the bone, and out of reach of pressure.

† This corresponds with the upper border of the patella, the limb being extended. The lower margin comes down to the tubercle of the tibia, as in Fig. 387. (See also *Brit. Med. Journ.*, 1864, vol. i. p. 416.)

line of the limb, he passes it through to the spot where it first entered, cutting outwards through everything behind the bone. The flap is then reflected, and the remainder of the soft parts divided straight down to the bone; the muscles are then slightly cleared upwards, and the saw applied "through the base of the condyles." The projecting part of the femur may be rounded off. Where there is any doubt about the vitality of the large anterior flap, a short posterior one should be made, the anterior one thus not needing to be so long.

Owing to the risk of sloughing of the long anterior flap, Lord Lister's modification, by which two shorter flaps are employed, is always to be preferred. "The surgeon first cuts transversely across the front of the limb from side to side at the level of the anterior tuberosity of the tibia, and joins the horns of this incision posteriorly by carrying the knife backwards obliquely at an angle of 45 degrees to the axis of the leg through the skin and fat. The limb being elevated, he dissects up the posterior skin flap, and then proceeds to raise the ring of integument as in a circular operation, taking due care to avoid scoring the subcutaneous tissue; and dividing the hamstrings as soon as they are exposed, and bending the knee, he finds no difficulty in exposing the upper border of the patella. He then sinks his knife through the insertion of the quadriceps, and having cleared the bone immediately above the articular cartilage, and holding the limb horizontal, he applies the

FIG. 388.



(Carden.)

FIG. 389.



saw vertically, and at the same time transversely to the axis of the limb (not of the bone), so as to ensure a horizontal surface for the patient to rest on."

ii. **Gritti's Trans-condyloid** (Figs. 390, 392, and 393). iii. **Stokes's Supra-condyloid Amputation** (Figs. 391, 394, and 395).

For fuller information on the above amputations I would refer my readers to a paper I contributed to the *Guy's Hosp. Reports*, vol. xxiii. p. 211, 1878.

But while this osteo-plastic method shares with that of Carden the advantages given above (p. 937), the difficulty of securing a satisfactory section of a small mobile bone like the patella, and, later, of retaining it accurately *in situ*, is usually very considerable. From an extended experience of this operation, I much prefer that of Stephen Smith when the conditions admit of it.

The two methods are often confused. Between them there is this all-important difference: in Gritti's the section of the femur is made *through* the condyles; in Stokes's, at least half an inch *above* them. In other words, the one operation is *trans-*, the other *supra-condyloid*.

On this point great stress has been laid, and very rightly, by Sir W. Stokes, and a comparison of the two operations will convince every one that he was correct. If the section of the femur be made through the condyles (Figs. 390, 393), the sawn patella will not fit down into place. It will either be drawn up altogether on to the front of the femur, or

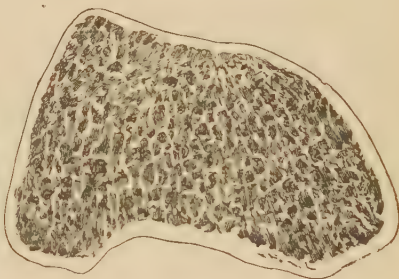
else will project forwards, somewhat like the half-open lid of a box (Figs. 392. 393), at an angle to the broad sawn surface, which is also too large for it to cover, and across, and off which it is liable to be shifted by the contraction of the quadriceps, if it has been found possible to get it into place. To effect this, an amount of force will be required which is almost certain to result in bruising of the cut periosteum on the edge of the femur, and

FIG. 390.



Gritti's trans-condyloid section of the femur, leaving a surface much too long and large for the sawn patella to fit.

FIG. 391.



Stokes's supra-condyloid section of the femur, leaving a surface much more easily fitted by the sawn patella.

consequent necrosis. If, on the other hand, the saw is made to pass a full inch *above* the condyles (Fig. 391), the patella will fall readily into place (Fig. 394), it will cover more completely the now smaller surface of the femur, and will remain easily *in situ* here, the flaps when brought together presenting the appearance shown in Fig. 395.

Operation.—An Esmarch's bandage having been applied, the limb brought over the edge of the table and supported, and the opposite one secured out of the way, the surgeon,

FIG. 392.



(Farabeuf.)

FIG. 393.

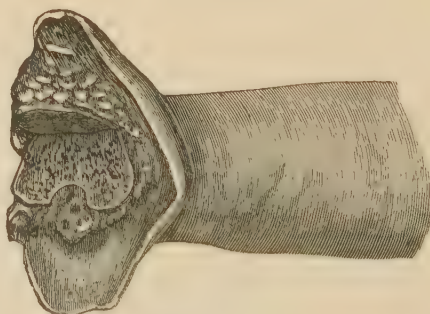
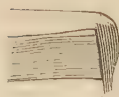


FIG. 394.



(Farabeuf.)

The flaps in Gritti's trans-condyloid amputation, showing the patella hitched and requiring force to adapt it to the femur, which is now too long as well as too broad.

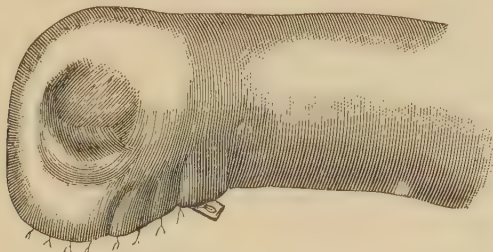
standing to the right of the limb, with his left index and thumb marking the base of the flap, makes an incision commencing (on the left side) an inch above and rather behind the external condyle, carried vertically downwards to a point opposite to the tibial tubercle, then broadly curved across the leg and carried upwards to a point opposite to that from which it started. This flap having been dissected upwards, together with the patella (after section of the ligamentum patellæ), a posterior flap is cut nearly as long as the anterior. This may be effected in one of two ways, either by the surgeon looking

over and then stooping a little (the limb being now raised), next drawing the knife from without inwards across the popliteal space, thus marking out and then dissecting up a skin flap, or by transfixing and cutting the flap from within outwards. Of the two I prefer the first: the latter is the speedier, but less suited to bulky limbs. The flaps being retracted, the soft parts are cut through with a circular sweep a full inch above the articular surface of the femur; the bone is then sawn through here, and the limb removed. The posterior surface of the patella is next removed with a metacarpal or small Butcher's saw. This last step is one of considerable difficulty, owing to the mobility of the bone; it will be facilitated by an assistant with both his hands everting and projecting the under-surface of the anterior flap, so as to make the patella stand out from it.

The vessels—popliteal, one or two articular, and the anastomotic—having been secured, drainage is provided, and the flaps are brought together with numerous points of suture, save at the angles (Fig. 395).

Even where the flaps are cut of proper length and the femur is sawn at the proper height, the patella may still not remain accurately *in situ*. If there seem any doubt on this point, or if the patient is very muscular, additional security may be given by passing sutures of sterilised silk between the tissues on the under-surface of the anterior flap, at

FIG. 395.



Appearance of the stump in a Stokes-Gritti's amputation. The patella has come easily into place. The drainage-tube shown might, in many cases, be dispensed with.

the edges of the patella, and the soft parts in the posterior flap (avoiding the vicinity of the large vessels). Wiring or pegging the bones or division of the rectus muscle on the under-surface of the anterior flap are unsatisfactory complications.

REMOVAL OF AN EXOSTOSIS FROM NEAR THE ADDUCTOR TUBERCLE.*

As these growths are by no means uncommon in adolescents, this operation will be briefly described here. Aseptic excision has now replaced any other operation, such as subcutaneous fracture.

Operation.—The parts having been thoroughly sterilised, the knee is flexed so as to bring down the synovial membrane, and the limb placed on its outer side. A free incision, about three and a-half inches long, is made over the growth, down to the vastus internus, and any superficial vessels attended to. The muscular fibres are then cleanly cut through, and the bluish-grey cartilage which caps the swelling now comes into view.† Any muscular branches being now carefully secured,

* This account will serve for the removal of other exostoses—*e.g.*, those met with at the deltoid insertion, the spine of the scapula, or the pelvis.

† Any synovia-like fluid now escaping comes probably from a bursa over the growth, not from the joint.

and the wound dried, the cut vastus is pulled aside with retractors, and the base of the growth being thoroughly exposed, it is shaved off with an osteotome or chisel, leaving exposed cancellous tissue. The muscular fibres are then united with sterilised silk, and drainage provided if needful. Strict aseptic precautions are taken throughout to secure primary union. The limb should be kept absolutely quiet on a back splint, and a Martin's bandage worn, later, for a short time.

FRACTURES OF THE FEMUR.

The following remarks apply, chiefly, to interference for ununited fractures: more immediate interference is chiefly called for in injuries to the lower end of the bone.

I. Ununited Fractures about the Neck.—Lord Lister recorded as long ago as 1871 (*Brit. Med. Journ.*, Aug. 26) the case of an ununited extra-capsular fracture of the femur in a man, aged 45, where, eighteen months after the injury, he cut down on the fragments, with antiseptic precautions, and gouged them, the fracture being then firmly put up. Recovery was complete, the man walking well.

Indications for this rarely called-for operation would be a patient before, or perhaps at, middle age, with good vitality and much pain or loss of function; there should be no evidence of osteoarthritis. Dr. L. Freeman, of Denver, has recorded one case of his own and collected thirteen others (*Ann. of Surg.*, 1904, vol. ii. p. 561). Dr. G. E. Davis (*ibidem*, Aug. 1905, p. 282) recorded a case of intra-capsular fracture successfully treated by a screw.

Operation.—The incision usually employed will be the anterior one.* All fibrous tissue between the fragments must be removed with scissors, gouge, &c. As little bone as possible is to be taken away. Drilling and fixation of the fragments is most difficult, partly from their position, partly from their softened condition. Screws, pegs, long nails, a gimlet left in eight weeks (Sayre), have been employed. They can only be introduced through a separate incision made over the outer aspect of the great trochanter. This bone must be well raised first and kept up by the peg, &c., owing to its tendency to drop backwards. The drill and peg must pass through the trochanter and neck well into the head. This requires much care. Whatever means of fixation is used should be left in until there is evidence of sufficient consolidation. As is the case elsewhere, a sinus often forms at the time that the screw, &c., becomes loose. The patient should be kept in bed for ten weeks. The results are encouraging, a satisfactory degree of mobility and good use of the limb being recorded in most cases.

Some shortening remains. In a few cases the fragments have again become loose. In another small series of cases the head of the femur has been removed; in spite of the shortening, the result is stated to have been good.

II. Ununited Fractures of the Shaft.—The large number of failures after operations for this condition are well known. The difficulties which may be present during and after these operations are very considerable, amongst them sufficient exposure of the fragments, keeping

* The presence of a skiagram may help the surgeon during the operation.

the wound aseptic, and the parts in correct apposition afterwards (*vide infra*), are most prominent.

Operation.—On the whole, the introduction of pegs having been less successful, sub-periosteal resection and fixation of the fragments is indicated here. This is especially so in long-standing cases, where other methods have failed, where there is very little attempt at repair, where an artificial joint exists, or where, after a severe injury, necrosis, atrophy of the fragments, and fibrous union have followed.

The operation of resection should always be performed with strict aseptic precautions, otherwise the risks of suppuration, osteo-myelitis, and pyæmia, owing to the very free incision required, the exposure of cancellous tissue, and, perhaps, of the medullary canal, are considerable.

The following most important preliminary points are given by Sir F. Treves (*Oper. Surg.*, vol. i. p. 588): “(1) It will be well in some cases to apply extension for a week or two before the operation; this overcomes the shortening produced by contracted muscles, and enables the surgeon to make trial of the splint he proposes to employ afterwards. (2) Before undertaking this operation the surgeon should understand that its success depends more upon the completeness of the arrangements that are made for keeping the bones in position after the operation than upon the operation itself, provided the latter be carried out with due care. . . . Care in the adjusting of the fragments, and infinite and continued care in the after-treatment, are the main elements of success in the present class of case. (3) In dealing with a fracture of the femur in an adult, it is well that the operation be performed as the patient lies upon the bed he will occupy throughout the whole treatment. Much moving of the patient after the operation is very undesirable, and a long thigh-splint without extension apparatus cannot be conveniently applied upon the operation table.” The limb having been rendered bloodless, if practicable, with Esmarch’s bandages,* the fracture is exposed by a free incision, five to six inches long, on the outer side of, and going down to, the bone. The incision should be made along the line of the inter-muscular septum between the vastus externus and biceps. If it be needful to expose the inner aspect of the fragments, a second incision must be made through the vastus internus so as to be external to the large vessels. The periosteum is next most carefully detached from the ends of the fragments, and a thin layer of bone, about a quarter of an inch in thickness, removed from each. The soft parts must be protected with spatulæ and retractors. Only if it be absolutely needful should the fragments be thrust or dragged out of the wound; any disturbance of the periosteum should be as restricted as possible. When the ends of the bone are cut square a saw is preferable. If they can be made to interlock, by shaping these in part into the form of a $\triangleright$, or by stepping them (p. 1021), a chisel will be useful: the ends of the bones are first steadied with forceps. The fragments are now brought into exact apposition, and to facilitate this it may be necessary to divide adhesions or tendons, or to remove any intervening

* This step is condemned by some, notably by Sir F. Treves (*loc. supra cit.*, p. 588). I admit that it leads to much oozing from the cut surfaces, but, having tried both ways, I am of opinion that this can be safely met by applying ample well-adjusted dressings before the bandage is removed, and that the advantage of a bloodless wound during a most difficult and prolonged operation is almost incalculable.

fibrous or fibro-cartilaginous material, or a sequestrum. If the fragments are successfully adjusted and carefully kept so (*vide supra*), the use of wire, pegs, and screws may be dispensed with. Their use, although it ensures correct apposition of the fragments, prolongs and complicates the operation, and may give considerable trouble later on. If it be determined to make use of wire, the ends are now to be drilled, the drill being entered on the superficial surface of each fragment, and then made to project in the centre of the medullary canal. They are next held together by passing sufficiently stout silver wire through the drill-holes, and twisting this up. The ends are next hammered down, *in situ*, three half-twists being made and the ends cut short. See the remarks, p. 968. Wire usually entails more disturbance of the parts; screws give a firmer command over the fragments; pegs or steel pins are the simplest if the bradawl used be large enough to render the following of its track easy. Other methods that may be found superior to wire are Mr. W. A. Lane's screws, p. 1017 (*Clin. Soc. Trans.*, 1894), and Prof. Senn's hollow perforated bone cylinders or ferrules. These are circular or triangular, and large enough to slip easily over the fragments. The most accessible fragment having been sufficiently isolated, the ferrule is slipped over it and far enough away from the line of fracture to clear the other fragment. After reduction has been accomplished the second fragment is engaged in the ring, which is then pushed back sufficiently far to grasp both fragments securely. If the ferrule rides too loosely, any space should be packed with chips of decalcified bone. The limb is put up in plaster of Paris with a sufficient interruption (p. 1013). If suppuration occur, the ferrules are removed by cutting through one side with bone forceps, after enlarging the sinus, when the parts are consolidated. If there is no suppuration, the ferrule will probably be absorbed (*Ann. of Surg.*, vol. ii. 1893, p. 125).

A full account of the clamp devised by Dr. C. Parkill and its various uses is given in the *Ann. of Surg.*, May, 1898. Here will be found also the reports of fourteen cases in which the clamp has been used. The fact that success was obtained in each of these cases constitutes a strong claim for a more extended trial. Owing to its numerous parts, it is complicated, and the projection of a portion of the instrument calls for constant attention to keeping the skin sterile. In the only case in which I have seen this clamp used it was not successful. The remarks made below on fractures of the leg should also be referred to.

III. Injuries about the lower end of the Femur.—*E.g.*, supra- and inter-condyloid fractures and injuries to the epiphysis. Where, after an attempt under anæsthesia, a skiagram, taken on the second or third day, shows that the position of the fragments is unsatisfactory, it is quite justifiable, especially in a young and healthy patient, to resort to operation if the surroundings of the surgeon are suitable. In the case of the shaft the dangers of the relations increase from below upwards; here, in addition to the importance of the relations, the presence of the knee-joint, the possibility of injury to the popliteal vessels,* the bulk and fixity of the lower fragment, have all to be remembered. Adhesions

* Edema of the foot, persisting after alteration in the position of the limb, will be an indication for operation.

here form so quickly that interference should be resorted to early in the first week. The following are the chief points which need attention. (1) The chief incision should be on the outer side along the outer border of the biceps tendon, prolonged upwards along the line of the external intermuscular septum already mentioned; in any extension of the incision below care must be taken of the external popliteal nerve. (2) If the joint be uninjured, the synovial membrane should be avoided by keeping the incision low down.* (3) Division of the tendo Achillis, while variable in the aid which it affords, should always be resorted to. (4) The position of the fragments,† the aspect of their surfaces, the amount of tilting, rotation, &c., being determined by inspection and a sterilised finger, reduction must be effected by manipulations aided by leverage. The wound and its adjacent area being protected with sterile gauze, extension is made on the leg in the extended and flexed positions, while the surgeon makes counter-extension on the upper fragment, aiding the replacement by his fingers in the wound. The difficulties now present are the locking of the lower fragment between the closely adjacent femur and tibia; in the case of a separated epiphysis this may have carried with it a portion of the diaphysis which may need careful enucleation, and, this failing, detachment with a chisel, or the upper end of the diaphysis may be held in a buttonhole-like slit by a detached sheath of periosteum, this requiring careful slitting up. If the leverage of a periosteal elevator is required, care must be taken not to inflict needless damage on the delicate and softened epiphysal structures. (5) When replacement has been effected there is not, in my experience, the same difficulty in retaining these fragments in position that is met with in injuries about the elbow-joint. If some means of retention is thought needful, pins or screws—and either must be of sufficient length—are usually preferable to wire. The heads must be left as flush with the bone as possible. To secure sufficient elevation and command over a fragment it is always permissible to make a separate puncture down to the bone for the preliminary introduction of the bradawl. (6) It is needless to insist on the need of the most rigid asepsis throughout. In my opinion, after these most difficult and complicated operations, drainage is always advisable, and the wounds should not be completely closed at first. (7) The after-position, whether flexed or extended, will mainly depend upon the position in which it has been found easiest to replace and fix the fragments. As I have stated, the amount of mobility of the joint, even where rapid healing has been secured, is often disappointing, and, in separation of the epiphysis especially, in addition to some stiffness of the joint and shortening, some degree of genu valgum or varum is very likely to follow if the limb be used prematurely.

* The persistent stiffness of the joint which is so liable to follow a successful reduction of the fragments would make one very chary of dividing the extensor, or opening the knee joint so as to insert a finger to aid in the replacement as advised by some. If the joint be infected, it is another matter.

† The difference in the displacement in a case of separated epiphysis and supra-condyloid fracture will be remembered. In the former case the epiphysis is displaced upwards, and the lower end of the diaphysis will be felt in the popliteal space. In the case of the fracture the lower fragment is drawn backwards, and arrested behind the upper, with its fractured surface looking into the space behind.

CHAPTER IV.

OPERATIONS INVOLVING THE KNEE-JOINT.

AMPUTATION THROUGH THE KNEE-JOINT.—ERASION OF THE KNEE-JOINT.—EXCISION OF THE KNEE-JOINT.—ARTHRODESIS.—WIRING THE PATELLA.—REMOVAL OF LOOSE CARTILAGES FROM THE KNEE-JOINT.—INJURED FIBRO-CARTILAGES AND OTHER CAUSES OF INTERNAL DERANGEMENT.

AMPUTATION THROUGH THE KNEE-JOINT (Fig. 396).

Chief Methods.

I. By Lateral Flaps. II. By Long Anterior and Short Posterior Flaps.—Of these the first is far the superior. The great objection to the second is, that in order to get sufficient covering to fall readily over the large condyles, a long anterior flap must be cut; as this must reach two inches below the tibial tubercle, a good deal of its blood-supply which comes from below—*e.g.*, from the recurrent tibial—must be cut off, and the flap is thus liable to slough. This risk is much diminished, and the blood-supply better equalised, by the method of lateral flaps.

I. *Amputation by Lateral Flaps.*—This, the method of Dr. Stephen Smith,* was brought before English surgeons by Mr. Bryant.† The femoral artery having been controlled, the limb supported over the edge of the table, and slightly flexed, the surgeon, standing on the right side of either limb, marks out two broad lateral flaps as follows: His left thumb and index finger being placed, the former over the centre of the head of the tibia, the latter at the corresponding point behind, opposite the centre of the joint, he marks out (in the case of the right limb) an inner flap by an incision which, commencing close to the index finger, is carried down along the back of the limb for about three inches and a half, and then curves upwards and forwards across the inner aspect of the leg, till it ends in front just below the thumb.‡ The knife not being taken off, a similar flap is then shaped

* *New York Journ. of Med.*, Sept. 1852; *Amer. Journ. Med. Sci.*, Jan. 1870.

† *Med.-Chir. Trans.*, vol. lxi. p. 163.

‡ Dr. S. Smith begins his incision about an inch below the tubercle of the tibia, and carries it up rather higher behind—viz., to the centre of the articulation. It will be found easier to open the joint and to detach the semilunar cartilages from the tibia by making the incision as recommended above.

from the outer side, but in the reverse direction. Dr. Stephen Smith calls attention to the following points: In making these flaps, they should be cut broad enough to secure ample covering for the condyles, and the inner one should be made additionally full as the internal condyle is longer than the external. The flaps should be at least three inches and a half long, if of equal length. They consist of skin and fasciæ. When they have been raised as far as the line of the articulation the ligamentum patellæ is severed, allowing the patella to go upwards. The soft parts around the joint are then cut through with a circular sweep, and the leg removed. In doing this, the limb being flexed to relax the parts and facilitate opening the joint, the semilunar cartilages will very likely be found closely encircling the condyles of the femur. Mr. Bryant, in the paper already quoted, and Dr. Brinton (*Philad. Med. Times*, Dec. 28, 1872), as long ago as 1872, have strongly advised that the semilunar cartilages should be left *in situ* by severing the coronary ligaments which tie them to the tibia. They thus, in Dr. Brinton's words, form "a cap, fitted on the end of the femur, which preserves all the fascial relations, effectually prevents retraction, and guards against the projection of the condyles." This precaution will obviate a serious objection to amputation through the knee-joint. For a time the patient bears his weight well on the end of the stump. But after some months the ends of the condyles (if unprotected by the menisci) begin to fret the thin overlying skin, and within a year of the amputation the patient, usually, has to have his artificial limb altered.

FIG. 396.



Amputation through knee-joint by lateral flaps. The incision has been begun unusually low down. (Bryant.)

II. By a Long Anterior and a Short Posterior Flap.—The position of the patient and the surgeon being as at p. 946, the latter with his left index and thumb on either side of the interval between the femur and tibia, enters his knife (in the case of the right limb) just below the finger and internal condyle, carries it straight down along the inner side of the leg till it reaches a spot two inches below the tibial tubercle,* then squarely across the leg till it reaches a corresponding point well back upon the outer side, and thence up to a point just below his thumb, or to the external condyle. This flap is then dissected up, containing the patella, as thickly as possible, and almost rectangular in shape, anything like pointing of its lower end being most carefully avoided, as certain to lead to sloughing.

This flap being raised, a posterior flap is made about two-thirds the length of the first, as at p. 930, either by dissection from without inwards, or by transfixion after disarticulation.

* Mr. Pollock (*Med.-Chir. Trans.*, vol. liii. p. 20) advises that the anterior flap should reach "quite five inches below the patella." It is difficult to see how sloughing can be avoided here, so much of the blood to this very long flap coming from below and being, of necessity, cut off.

ERASION* OF THE KNEE-JOINT.

Definition.—By this operation, which we owe to G. A. Wright,† of Manchester, is meant a systematic removal of the tuberculous synovial membrane; the ligaments, as far as these are diseased, are also removed, the bones and cartilage being dealt with by paring with a knife, or by a gouge or sharp spoon. The more advanced the disease the less typical will be the erosion. When sinuses are present, and the joint is the seat of mixed infection, the risks of failure of any attempt to save the limb are hugely increased. Where an abscess is present, G. A. Wright (*loc. supra cit.*) deals with this by stages. The abscess should be thoroughly cleared out first, the wound closed, and erosion performed after healing has taken place. This plan is not applicable to cases where the whole joint is suppurating. Where sinuses exist he has still found it possible in some cases to render the parts aseptic by excision of the walls of the tuberculous tracts, and the use of powerful disinfectants, of which he considers turpentine to be one of the best (Vol. I. p. 745). Thus while erosion is directed chiefly to the soft structures which are usually the primary seat of the disease, it entails a need of much wider attention to other structures, especially in hospital cases which have passed beyond the desired early stage.

The old excision of former days, with the attention of the operator directed to the bones rather than to the synovial membrane, is an operation of the past. Erosion is, when possible, always to be preferred to excision. With increasing experience the more will a surgeon's operation here partake of an erosion, especially if he has much to do with children. But in my experience, with the advanced cases which are still so frequent, the operation is rarely an erosion alone; in the great majority of cases the ends of the bones are affected. While the gouge is invariably, at any age, to be preferred to the saw, as some surgeons still prefer excision, and as excision may be required after the failure of erosion in tuberculous cases, and in a few which are not tuberculous, *e.g.*, osteo-arthritis, I have described both operations.

Value of Erosion as compared with Excision; Suitable and Unsuitable Cases.—Where a knee-joint, the site of tuberculous trouble, resists, in hospital patients, non-operative treatment continued for three months; where there is but little evidence of caseation in the joint (very difficult to tell, but indicated by chronic obstinacy of the disease, by spots where the feel is distinctly doughy, or becoming bluish in tint)—in other words, where the disease is early, but, owing to the patient's surroundings, will go on from bad to worse, erosion is indicated and far preferable to excision. Its *advantages* are, (1) There is no removal of bone-slices, and still less any interference with the epiphyses. Thus the only shortening which follows is that due to premature synostosis of

* Arthroectomy was a term introduced by Volkmann (*Cent. f. Chir.*, 1888); it is less accurate, and, etymologically, comes too near to excision.

† *Lancet*, 1881, vol. ii. p. 992; *Med. Chron.*, July 1885; and one together with Mr. Haslam, *Brit. Med. Journ.*, vol. ii. 1903, p. 888. See also a paper by Mr. Shield (*Ann. of Surg.*, Feb. 1888), and one by Mr. E. Owen (*Med.-Chir. Trans.*, vol. lxxii. p. 56).

the epiphysial line (W. Cheyne), and disuse of the limb, too often allowed to become flexed. This advantage will be at once recognised when it is remembered that (p. 951) the increase in length of the femur takes place chiefly at the junction of its shaft with the lower epiphysis, and in the case of the tibia at its upper epiphysis. In one of my cases, a girl of 11, there was not only no shortening, but repeated careful measurements showed half an inch increase of length, perhaps due to the increase of vascularity after the operation, about the above-mentioned epiphyses. (2) With regard to the retention of mobility, and the advantage at first claimed for it, this, in my opinion, has been much exaggerated. I have no doubt whatever that a larger number of carefully published cases will show that where movement is sought for, the risk is run of a certain degree of permanent flexion, of attacks of pain and swelling, and of the formation of troublesome sinuses. I should strongly dissuade, from any attempt to secure mobility in the case of the knee and ankle. (3) The ligaments are less interfered with, and thus, the ties of the joint being preserved, firm union is more speedy. This advantage is only true of the desirable early cases, and is not to be expected where the whole of the interior of the joint has been interfered with to allow of eradication of every diseased structure. (4) If performed early, erosion, as excision does, but in a less expensive way, cuts short the disease, and thus gives a considerable saving of time in children, at an age when every month is of great importance. (5) It is better suited to young children. Thus, as it does not arrest development, it may be used very early. Wright has operated "with perfect success in a child under two years of age."

The *disadvantage* of erosion—I am speaking only from an experience of twenty-six cases, of which two required excision later, and two others amputation—is, I think, chiefly this, that if the operation fail, excision is rendered much more difficult. I cannot here at all agree with the statement of my old friend, the chief authority on this subject, that erosion, if it fail, leaves the limb little, if at all, in worse condition for excision afterwards. This is true of the limb, but not of the joint. In one of my erosions which required excision, I found that the previous operation had entirely obliterated the usual landmarks, and that great difficulty was experienced and much care needed in dealing with such parts as the remains of the posterior ligament. The ultimate result here (*vide infra*) was good. Another minor disadvantage, and one shared by excision, is the after-flexion. In my opinion the liability to this is greater after erosion. After both operations, prolonged fixation, for at least two years after erosion, is to be insisted upon.

To recapitulate, the *cases most suitable for erosion* are those where the disease is limited, or almost limited, to the synovial membrane, with little, if any, caseation; where the cartilage and bones are almost intact, where there are no abscesses or sinuses, where there is no evidence of other tuberculous disease,* and where the power of repair is satisfactory.

* That bone disease elsewhere is not absolutely prohibitive is shown by the following: Three of my seventy-seven cases of excision (footnote, p. 951) had had spinal disease, well-marked bosses remaining in all. Each made an excellent recovery. One I saw

Operation.—The preliminaries are the same as for excision (p. 953). A trans-patellar incision (Fig. 398, p. 954) should be employed. Many other incisions, *e.g.*, a flap usually going through the ligament, a median vertical one splitting the quadriceps, patella and ligament, and two lateral incisions, have all been employed. I have used the first, but prefer that through the patella as best combining adequate exposure of the parts and retention of the patella in order to meet the inevitable tendency to flexion. But to ensure thorough exposure of the supra-patellar region, a very dangerous area on account of its numerous nooks and crannies, which give lurking-places to tuberculous mischief, I always slit this pouch right up to its very top with a sharp-pointed bistoury, thus dividing the upper flap into two. G. A. Wright in his last paper writes: "I now do the transverse trans-patellar operation with a vertical upward incision occasionally added to facilitate removal of disease tracking up the sub-crural sac. I usually divide the aponeurosis on each side of each half of the patella for an inch or more to facilitate exposure." The flaps being then, one by one, thoroughly everted with a sharp hook, taking the upper half of the joint first, I seize the tip of one of the flaps with mouse-tooth forceps, and then, with blunt-pointed scissors curved on the flat, dissect the diseased synovial membrane off the under-surface of the split quadriceps expansion in a continuous strip till the uppermost limit of the supra-patellar pouch is reached. The reflection of the synovial membrane over the front of the femur is then dealt with in the same way, leaving the periosteum on this quite clean. The joint being then well bent, and the tibia being brought forward as directed (p. 956, Fig. 399), the crucial ligaments, the semilunar cartilages, the inter-condyloid notch, and the synovial reflections behind the crucial ligaments are carefully inspected. To do this thoroughly, it is absolutely needful to divide the lateral ligaments sufficiently. With regard to the other structures, some retain the semilunar cartilages, if healthy; others remove them in any case. For my part, as it is so essential to remove *all* the synovial membrane, and this is impossible unless the semilunar cartilages go, I always remove them. With regard to the crucial ligaments, the anterior nearly always requires removal; as regards the posterior, the whole ligament, or as much of it as possible, should be left, since its removal is extremely liable to be followed by backward displacement of the tibia. The inter-condyloid notch, and the reflection behind the crucial ligaments, is then taken in hand, very wide flexion of the joint, and a finger of an assistant in the popliteal space, here facilitating this, the most difficult and important part of the operation. When much disease is present here in the synovial membrane, both crucial ligaments must be unhesitatingly removed, and, if

fourteen years later. In spite of the old spinal disease and marked shortening of the limb owing to excision being required after erosion, this patient was able to make his way daily from Brixton to Westminster and back, and earn his living as a solicitor's clerk. Limited tuberculous disease of the tarsus existed in two others and was cured by operation by the time the knee was sound. In two, disease of the hip-joint coexisted; in one, the limb had to be removed by a Furneaux Jordan amputation, the child recovering; in the other (the disease being on the opposite side), the knee, after a trans-patellar excision, healed soundly, the hip disease being cured by rest. A case in which both knees were excised is shown at p. 962.

needful, the overhanging posterior part of the condyles must be cut away. In dealing with the synovial membrane in the inter-condyloid notch, the surgeon must remember that he will never have a similar chance of dealing with the disease here, and that, if any is left behind, excision, and perhaps amputation, will be called for. The synovial membrane around the lower half of the patella is then removed, and finally the ends of the bones are examined. Any pits and foci are gouged out, and more extensive ulceration shaved off with a strong sharp knife. Drainage is rarely required, save of course in infected cases, or where the condition of the parts will certainly give rise to much oozing later. The two ends of the wound should never be closely sutured. The dressings are applied with the precautions given at p. 959, and not until all is completed is the Esmarch's bandage removed. Throughout the operation in infected cases, irrigation with lot. hydr. perch., 1 in 3000, should be diligently employed.

The after-treatment is the same as after excision (p. 961). As there is the same long-continued tendency for the limb to become flexed, there is the same urgent need for a rigid apparatus for at least two years.

Causes of Failure after Erasion.—These are much the same as those given at p. 961. The chief of them, persistence of the disease from failure to eradicate it at the first operation, is there dealt with.

EXCISION* OF THE KNEE-JOINT.

(Figs. 397—404.)

Indications.—A. FOR DISEASE. B. INJURY.

A. FOR DISEASE.

(i.) Tuberculous disease.

On this subject the remarks already made (p. 948) on erasion should be referred to. The following points require mention as well: One is age. The chief growth of the femur takes place at its lower end (p. 958). By fifteen, and still more by seventeen, the growth of the bone is largely completed. Thus, in young subjects, especially before ten, as little of the bones as possible should be removed, and gouging should largely replace the saw. While the old-fashioned excision, in which attention was chiefly directed to the ends of the bones, is, as already stated, very largely an operation of the past in tuberculous

* This operation is contrasted with erasion of the knee at p. 948. I may perhaps here say that I have excised the knee seventy-seven times, and performed erasion on twenty-six occasions. Of the cases of excision four died of effects of the operation, one (mentioned below) from shock, another (also mentioned below), with bony ankylosis and angular displacement, from threatening gangrene, a third from surgical scarlet fever, and a fourth from septicæmia. The child with surgical scarlet fever was moved, during my absence from town, into an empty, chilly ward; the eruption became dusky and then suppressed; coma, followed by death, ensued. Six have been submitted to amputation, making good recoveries. This number would probably have been seven, as a patient, aged 53, whose knee had been excised for disorganisation after osteo-arthritis and whom I had advised to submit to amputation, went out able to walk a little with a stick, but with two sinuses. Of the cases of erasion I had to perform excision in two, and amputation in two others. All the patients recovered.

cases, it may still be called for in the following: where the disease is of long standing; where there is backward displacement of the tibia; where the disease has started as an epiphysial osteitis.

While the subject of tuberculous disease of the knee-joint is being considered, the question of amputation will arise in certain cases. Sir H. Howse (*Guy's Hosp. Rep.*, 1894) gives the following conditions which call for this step. They are: A. Constitutional. (a) Lardaceous disease. (β) Tuberculous disease of the lungs or other viscus. (γ) Great emaciation without any very evident visceral disease. (δ) Multiple joint disease (*vide* p. 949). B. Local. (a) Osteitis or periostitis extending along the shafts of either femur or tibia, as shown by great thickness or tenderness of the bone.* (β) Very great infiltration of tuberculous material into the soft parts, extending far beyond the limits of the joint.

(ii.) Some cases of failed erosion in which the mischief is too extensive for curetting, but does not call for amputation.

(iii.) Threatening disorganisation of the knee, with caries, after pyæmia, and other forms of infective arthritis.

(iv.) Osteo-arthritis.—Where one joint only is affected, and the patient is not past middle life, excision gives good results. The surgeon must be prepared for sawing very dense bones.

(v.) Ankylosis.—Excision can usually be abandoned here for better operations (p. 963), *e.g.*, dividing, with aseptic precautions, the union, with an osteotome introduced first on one side and then on the other, and worked forwards under the patella and skin, and backwards as far as the popliteal artery allows. If this fail, a double osteotomy of the femur and tibia should be performed rather than excision, an operation which, in the case of true bony ankylosis, is liable to be severe, prolonged, and to leave a large wound, and, in the case of young subjects, to lead to further shortening of a limb already atrophied and weakened from disease. I would strongly urge caution in rapidly and completely straightening a knee-joint which has long been the seat of a bony ankylosis in a bad position and call attention to the case related at p. 963.

(vi.) Old, Neglected Infantile Paralysis.—The question of excision here is referred to (p. 963), under the heading of Arthrodesis.

B. INJURY.—Here such injuries as those from gunshot and those from a lacerated wound or a compound fracture must be considered separately.

1. Gunshot.—“The results of the excisions of the knee-joint performed during the late civil war, whether the operations were primary, intermediary, or secondary, were not very encouraging, forty-four of the fifty-four cases in which the issues were ascertained having terminated fatally, a mortality of 81·4 per cent., exceeding the mortality of the amputations of the thigh (53·8) by 27·6 per cent.” (Otis, *loc. supra cit.*, p. 419). Sir T. Longmore (*Syst. of Surg.*, vol. i. p. 565) lays down these definite rules: “From all the experience which has been gained regarding gunshot wounds in which the knee-joint has been opened, especially if the surfaces of the bone have escaped damage, as may occasionally happen with modern narrow rifle bullets, and even in other cases where one

* Sir H. Howse points out that, occasionally, tenderness and thickening may be due to a sequestrum, which may be successfully removed, and later on a useful limb obtained by excision.

of the bones has been fissured, or partial fracture has occurred, provided early immobilisation of the injured parts can be secured, antiseptic treatment carried out, and the general surroundings are sufficiently hygienic, it may now be laid down as a rule that conservative treatment ought to be adopted. When, however, the circumstances under which the wounds have been inflicted are such that the precautionary methods and modes of treatment mentioned cannot be put into practice, when the patients are liable to be moved frequently or to long distances hurriedly, and without adequate protection, or when the joint is not only penetrated, but the surrounding coverings are much lacerated, or the bones are comminuted and the fragments completely detached, the sacrifice of the limb by amputation above the joint is the only measure calculated to afford a fair promise of safety of life to the patient."

Mr. Makins, C.B., in his standard work ("Surgical Experiences in South Africa, 1899—1900"), from which I have already quoted, writes (p. 238), that while the knee-joint was the one most commonly injured, "injuries to the joint gave less anxiety than is the case in civil practice. The old difficulty of deciding on partial as against full excision or amputation was never met with by us. We had merely to do our first dressings with care, fix the joint for a short period, and be careful to commence passive movements as soon as the wounds were properly healed to obtain in the great majority of cases perfect results. If suppuration occurred, the choice between incision and amputation had to be considered. Amputation was sometimes indicated in cases of severe bone-splintering, but was as a rule only performed after an ineffectual trial to cut short general infection of the septicæmic type by incision." Association of popliteal aneurysm with wounds of the knee-joint was comparatively common.

2. Injuries other than gunshot.—Excision is rarely practicable here. A very careful consideration of the local and general conditions present is needful. Amongst the former, damage limited to the articular surfaces, but little splintering of the shafts of the bones, and an intact condition of the soft parts behind the joint are absolutely essential. Not less important is it to weigh the more general points connected with the patient—viz., his age not reckoned by years only, the condition of his viscera, and his habits; all these points are considered in the account of "The Treatment of Compound Fractures," given later on.

Operation.—Before and throughout an excision of the knee, or rather a combination of partial excision with erosion, the operator should bear in mind the following points: (1) to remove every atom of the disease; (2) to secure good drainage; (3) to leave the bones in good position; (4) to ensure absolute immobility afterwards; (5) to watch for and at once attack any relapse. The more I performed this operation, the more did I feel the truth of the words of Prof. Bruns, of Tübingen, that, while formerly its chief object was to remove all affected bone, it should now be considered of chief importance to remove all the tuberculous material that can possibly be got away, and that the surgeon should not content himself with snipping away all he can, leaving the rest to caseate or become scar-tissue if it will, but pursue it with the same earnest aim of extermination as he would in the case of malignant disease. I would not by the above seem to speak slightly of the value of securing healthy and correctly sawn surfaces of bone, as on these largely depends firm ankylosis and a sound and useful limb, but I would insist on the fact that such surfaces are secured in vain if tuberculous material is allowed to remain, and that other instruments—*e.g.*, sharp spoons and scissors curved on the flat—are to the full as useful as the saw.

Before the time of the excision, any flexion of the knee should be corrected as far as possible by careful weight-extension. A knee should never be excised while flexed. Such a step will only be liable to lead to removing bone needlessly in order to straighten the limb. The risk of gangrene is alluded to at p. 963.

The parts having been duly sterilised, and an Esmarch's bandage* applied at the top of the thigh, the limb is brought over the edge of the table, flexed, and held by an assistant as in Fig. 399.

From the moment of commencing the operation to its very close the surgeon must bear in mind the inveteracy of tuberculous material (malignancy would probably not be too strong a word), and in his endeavours to extirpate the disease completely his operation will combine the operations of erosion and excision rather than follow the typical lines of either.†

The following modes of exposing the joint will be given here :

A. Transverse, removing the Patella. B. Transverse, through the Patella. C. The Semilunar Flap (lately recommended by Mr. Barker, and attributed by him to Moreau).

FIG. 397.



Transverse incision, the patella being removed.

FIG. 398.



Trans-patellar incision.

A. Transverse, removing the Patella (Fig. 397).—This, the older method, is still resorted to by those surgeons who, like Sir H. Howse, believe that, if the patella is retained, a most serious risk is run of

* Some object to the bandage as needless and as likely to lead to troublesome oozing after the operation. This may be met by firm pressure and even bandaging on of the dressings, so as to distribute any oozing uniformly throughout them. If an Esmarch's bandage is not applied, the bleeding during the operation interferes with the removal of diseased tissues, requires constant pressure to arrest it, and taxes the patient's resources considerably. Its use meets another risk, which is possibly hypothetical, and that is, it renders impossible the general diffusion of tuberculous material by the cut veins and lymphatics. The application of one bandage, preceded by due elevation of the limb, suffices. The bandage must be applied as high as possible, so as to be above the splint. As in all prolonged operations, to avoid harmful pressure on the nerves, it is well to apply the bandage over a collar of boracic acid lint.

† If operations for tuberculous knee are resorted to at an earlier stage the bones will less and less need interfering with.

leaving behind tuberculous material which will require removal later on under less favourable circumstances, and this failing, may lead to amputation.

The surgeon, standing on the left* side of the diseased knee (the opposite limb being tied to the table), makes an incision right across the joint from the back of one condyle to that of the other.† This incision passes over the lower part of the patella and exposes the lateral ligaments at once. The soft parts being then dissected up for two inches above the patella, so as to expose the supra-patellar pouch, deep incisions are made above and below the patella, which is then removed and the joint opened.

If the patella is ankylosed to the condyles, it must be removed by a blunt elevator, aided by a narrow saw, or, better, by an osteotome and mallet. No violence should be used in opening a joint partially ankylosed, or the epiphyses may easily be separated from the shaft, especially in a child.

I invariably, when raising the flap of soft parts in an excision of the knee, however performed, slit them up by a vertical incision, going to the upper limit of the supra-patellar pouch, so as to expose fully all its folds and recesses. Unless this is done, tuberculous material is very easily left behind, and, later on breaking down, leads to œdema, persistent sinuses, perforation of the pouch and spread of disease amongst the adductors and into the vicinity of the femoral, and perforating vessels, where it is impossible to eradicate it, amputation being eventually called for.

B. Transverse, through the Patella (Fig. 398).—This method, by preserving the patella and the insertion of the quadriceps, partly counterbalances the flexing action of the ham-strings (p. 961) at the same time. Used by Volkmann many years ago, it was again brought under the notice of English surgeons by Mr. Golding Bird in a case which he brought before the Clinical Society (*Trans.*, vol. xvi. p. 82).

For arguments against preserving the patella I must refer my readers to Sir H. Howse's article (*loc. supra cit.*). I am of opinion, myself, that in young subjects where the union is certain to yield for some time, it is well worth while, in cases where the disease is not too advanced, to preserve the patella, though, to ensure the full benefit of this step, fresh osseous surfaces should be prepared on this bone and on the femur and tibia, so as to promote bony union. Another and minor argument in favour of preserving this bone is that the anastomoses about the joint are less interfered with. This method is not adapted to cases where caseation is advanced, and its adoption only lessens, but does not remove, the liability to subsequent flexion.

The transverse incision is made here much as in the first method, only across the middle of the patella; this is sawn through or divided with a stout knife, the fragments turned up and down, and the joint freely opened (Fig. 398).

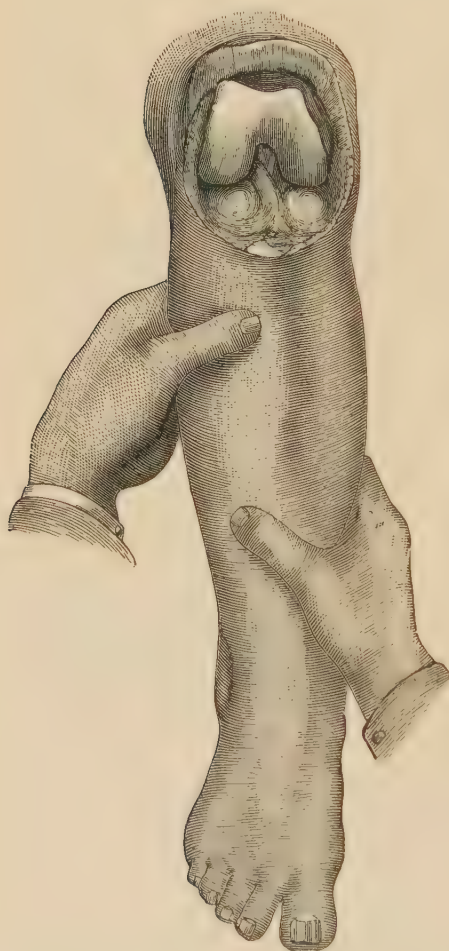
C. Semilunar Flap (Moreau, Barker).—Here a large U-shaped flap

* This position renders it much easier for him to saw the femur and tibia.

† Beyond this spot the incision should not go, for fear of wounding the internal saphena vein. This would lead to troublesome œdema of the foot and leg, and, if the wound should become infected, might bring about phlebitis and pyæmia.

is raised by a semilunar incision, starting above one condyle, descending to the level of the tibial tubercle, crossing the leg here and running up to a corresponding point on the other side. In raising this flap, which includes all the soft parts down to the bone, either the ligamentum patellæ should be severed (suturing of this being resorted to later), or the tuberosity, attached to the ligament, is removed with a chisel, and subsequently wired down (Barker).

FIG. 399.



The joint having been opened by one of the above incisions, it is well to slit with a sharp bistoury the supra-patellar pouch* up to its upper limits (readily reached by a finger), so as to lay bare every crevice and to remove every atom of diseased tissue. The cut margins being held on the stretch by two Spencer Wells's forceps, the surgeon with mouse-toothed forceps seizes the cut edge of the synovial lining of the capsule, and with curved scissors removes it in one piece, first from under the vasti muscles and then along its reflexion on to the femur down to where it ceases at the margins of the articular cartilage.

Next the lateral and crucial ligaments are examined, and every particle of diseased tissue removed, only bright, glistening, clearly healthy ligamentous tissue being left.† But as naked-eye examination in parts perhaps not absolutely bloodless may easily be fallacious, it is much better in doubtful cases to remove these completely than to run any risk whatever. The assistant who is in charge of the limb now

brings the head of the tibia well into view by pulling the calf of the leg well forward with one hand while he further dislocates the bone by pushing up the leg (Fig. 399).

* I look on this as one of the most cardinal points of the operation.

† Prof. Ollier (*loc. infra cit.* and *Rev. de Chir.*, 1882) drew attention to preserving the lateral ligaments, if possible, together with all healthy periosteum and capsule—*i.e.*, those tissues which will keep the bones in place and which will tend to produce ossifying material. This will not interfere, if carefully carried out, with extirpating diseased parts, while it will go far to prevent progressive flexion of the joint.

The condition of the semilunar cartilages is next examined, and if they are invaded by tuberculous tissue, if it is intended to perform a complete excision, they must be cut away entirely.

The back of the joint is next taken in hand. This region can be far more effectively dealt with after removal of the bones. If, owing to the case being an early one, with little or no caries, the surgeon desires to remain content with an erosion, he must still deal thoroughly with the posterior ligament* and deeper parts of the sides of the joint with all recesses and folds of the synovial membrane. To expose these parts thoroughly is a matter of some difficulty. The assistant should manipulate the limb as above directed at one time, at another flex the leg back towards the table, while occasionally a sterilised finger in the popliteal space will keep within reach any altered tissue that it is desired to deal with. Every pains must be taken to use the scissors systematically and thoroughly here as elsewhere until healthy tissues are reached, and not to dread the popliteal artery too much. This should be enforced for two reasons.

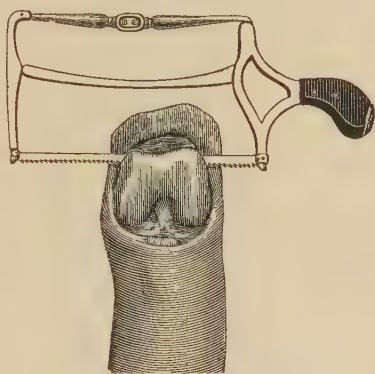
If any diseased tissue is left here, it will be shut in after the limb is extended and be impossible to deal with, save by a fresh and probably unsuccessful operation. Again, there is always a risk, especially in a surgeon's earlier operations, of his not dealing with disease here with sufficient thoroughness from dread of injuring the popliteal artery. This vessel may be avoided by (1) not dipping the points of the scissors deeply, but using the blades as far as possible parallel with the course of the vessel; (2) remembering that even after the posterior crucial ligament has been removed (a detail often imperfectly carried out) there is still a considerable thickness of tissue in front of the artery.

After all diseased tissues at the back have been thoroughly eradicated, the deeper aspects of the sides of the joint must be examined. Where caseating foci have spread down on the inner side of the joint, the tendons of the sartorius, semi-membranosus, and semi-tendinosus may need exposing.

It remains to describe the removal of the bones in case erosion is not sufficient. Where excision is evidently needed, the bones should be sawn after the supra-patellar pouch is cleared out, and before the posterior aspect of the joint is taken in hand, as this step will be much facilitated thereby.

The femur, held as steady as possible, is taken first. A groove for the saw is first so marked out with the scalpel as to remove about one-third of the condyles. In severer cases, or where the above section will clearly be insufficient, half, or even two-thirds, of the articular

FIG. 400.



* This and the posterior parts of the semilunar fibro-cartilages are liable to be inefficiently treated.

surface may be removed, but no section should be made farther back than this, or the epiphysis will be trenched upon with serious after-results.* Care should be taken, in making the section of the femur, to ensure that the plane of the sawn surface shall be at right angles to the axis of the shaft. Sir H. Howse prefers to saw the femur while this is held vertically.

The tibia is taken next, and a groove marked out with the knife about half an inch below the articular cartilage. A Butcher's saw, set horizontally, is used from behind forwards, and on a perfectly level plane. Neither here nor in sawing the femur must the slightest wobbling of the saw be permitted.

About half an inch only of the tibia should be removed, just enough in fact to expose healthy cancellous tissue, and no more. Of the femur no more than an inch and a half should be removed if possible.† Any soft, yellow, cheesy, fatty patches, any cancellous tissue into which pulpy tissue has dipped after perforating the cartilage, should be

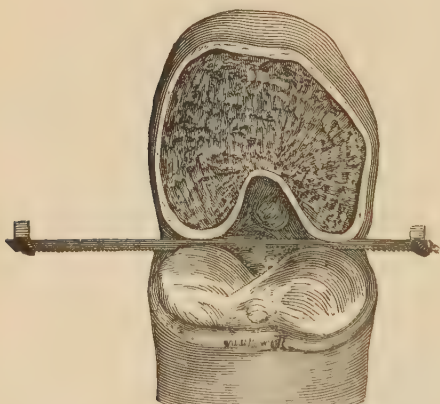
carefully removed with a gouge. Where, however, there is much caries, or the above patches are numerous, breaking down readily under the finger-nail, more than one slice of bone had better be removed.

The whole wound is now finally most carefully scrutinised, every outlying angle and recess being examined for tuberculous tissue left behind.

The Esmarch's bandage is now by some removed, and while sterile pads wrung out of hot 1 in 2,000 hydr. perch. are held firmly over the sawn tibia, any bleeding points in the upper

half of the wound are attended to. The safest way of arresting the bleeding is by under-running with chromic gut and fine needles all the vessels which spirt,‡ as practised by Sir H. Howse, or, as I greatly

FIG. 401.



* Dr. Hoffa, of Wurzburg (*Arch. f. klin. Chir.*, Band xxii. Heft 4, 1885; *Annals of Surgery*, March, 1886), brings forward cases to show that removal of both epiphyses led, at the end of ten years, to shortening, amounting to $25\frac{1}{2}$ cm. (1 cm. = $\frac{1}{16}$ inch), while in another case it amounted in two years to 10 cm. Loss of the femoral epiphysis alone showed 17 cm. of shortening in six years, and 7 cm. in a year and a half. Two cases of the like duration affecting the tibial line showed respectively $15\frac{1}{2}$ and 6 cm. It is, however, well known that considerable shortening may occur in cases treated expectantly.

† If the surgeon is obliged to trench upon the epiphyses it should be with the gouge, and not with the saw, if possible. In one case of a boy, aged 7, the bones being carious, soft, and fatty, a large patch of cheesy, fatty bone presented itself in the head of the tibia after the first slice had been removed. On removing this, the gouge entered the medullary canal, which was exposed, gaping on the sawn surface. I was doubtful how far union would take place here, but three years later the boy had a most useful limb, probably from a ring of epiphysial tissue being left.

‡ The following vessels will be found to give the chief trouble after a combined

prefer, by Mr. Barker's plan (*vide infra*). Bleeding from the cancellous tissue will be arrested by placing the bones in contact. If there is any tendency of the edges of the skin to fold in, these must be shortened.

The best means of meeting the hæmorrhage, and one which I have followed in all my later cases of excision and erosion, is that advised by Mr. Barker (Hunt. Lect., *supra cit.*). The Esmarch's bandage is here not removed until the dressings in sufficiently thick successive layers—*e.g.*, iodoform gauze and salicylic wool—are firmly bandaged in position. To admit of sufficient pressure being applied to check the oozing and to distribute it uniformly throughout the dressings, a sterile white bandage should first be applied from the foot to the upper third of the leg. If one of Sir H. Howse's splints is employed, the Esmarch's bandage must be applied sufficiently high up the thigh not to interfere with the limb being placed in the splint, as this has to be done before the dressings are applied. I have found this plan most satisfactory.

The patella, if sawn, is now drilled and wired, or united with stout silk or chromic gut. I prefer the first, the wire being cut short and embedded in the front of the patella in the way described at p. 971. As an additional precaution against the inevitable tendency to flexion, Mr. A. H. Tubby advises (*Brit. Med. Journ.*, vol. ii., 1903, p. 893) that the anterior aspects of the ends of the femur and tibia and the posterior aspects of the patella be removed. The four portions of bone are then united with a silver wire, which is embedded.

The question now arises whether the tibia and femur should be united by wiring or pegging.* I am of opinion that if the bones have been so sawn as to bring their faces squarely together, with sufficiently exact closeness to prevent more than a finger-nail being inserted between them, and if they are put up with the security which is given by Sir H. Howse's method, the above aids are not needed.†

Failure of excision is due to erosion and excision : one or two running down in the periosteum over the femur, one or two in the cut periosteum surrounding the sawn margin of the tibia, and one from the *azygos* articular in the posterior ligament.

* The bones have been united with different forms of pegs or nails, or by wire, stout carbolised silk, or chromic gut.

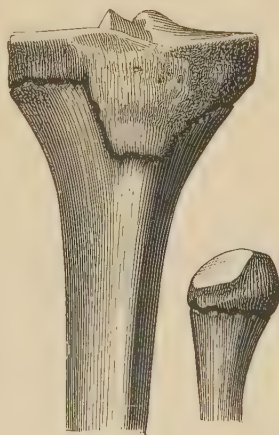
† I may be speaking with insufficient knowledge, but I am under a strong impression

FIG. 402.



This and the next figure show the line of the epiphyses which enter into the knee-joint, seen from the front. That of the fibula is also seen. They are taken from a well-grown subject of about 18. (Farabeuf.)

FIG. 403.



not to deficiency of repair in the bones, but, as a rule, to persistence of tuberculous material.

The need of drainage must vary with the experience of the operator. If the bone surfaces are well together, if the angles of the wound are left open, and if aseptic precautions have been taken throughout, drainage is rarely required. Two or three sutures may be made use of in the middle of the incision, the sides being always left open. Before closing the wound, I rub a little sterilised aristol over the different surfaces, and dry these scrupulously, before the sutures are in place. Sir H. Howse's splint is now applied. To those who are not familiar with it the following brief account* may be useful. The arrangement will be found most simple, and equally efficient in admitting of antiseptic dressing and maintaining the parts in absolute rest. The splint consists of two interrupted tinned-iron troughs for the thigh and leg joined by a posterior bar. This is from four to six inches long, according to the age of the patient; it is convex from side to side to avoid cutting into the popliteal space, and can be lengthened or shortened if any alterations in the interruption are required. At the end of the splint is an adjustable foot-piece.

The limb being laid in the splint, attention must be paid to the posterior bar being in the centre of the popliteal space; the foot must be well down on the foot-piece; if the splint grips the thigh or leg too tightly or rides too loosely, it must be bent out or in with iron "crows." The dressings are now applied as at p. 959. Great care must be taken to bandage from below upwards and from within outwards, the bandage being laid on evenly and firmly so as to distribute the discharges evenly right through the dressings, and to prevent their coming through at one or two spots. The splint is next secured to the limb with "waxed bandages," prepared by passing them through a mixture of ordinary yellow wax and olive oil, in proportions sufficient to make the wax soft and workable. After they are applied to the leg and thigh they are painted over with a little hot wax-mixture, so as to make them weld into one mass.† The limb, thus secured, is slung with cord and pulley to Sir H. Howse's modification of Salter's cradle. This occupies the lower part of the bed; the patient lies on a half water-bed. Thomas's knee-splint may also be used. G. A. Wright employs a back and two side splints for about three weeks, and then a Thomas's splint, which is kept on for at least two years.

The chief points now are (1) to ensure as absolute immobility as possible; (2) to employ as infrequent‡ dressings as practicable; (3) to

that the advocates of these aids have not made trial of the absolute fixity ensured by a well-applied Howse's splint (*vide infra*). Mr. Morratt Baker's and Mr. Howard Marsh's methods of fixing the bones by steel or bone pins will be found in the *Brit. Med. Journ.*, 1887, vol. xi. pp. 321, 389.

* *Guy's Hosp. Reports*, 1877, vol. xxii. p. 503, and the accompanying plate.

† The splint is usually lined with lint wrung out of the above mixture, or boracic acid lint. But the popliteal bar and any of the splint close to the wound must be metal only, uncovered, to prevent infection. If any spaces exist between the limb and the splint they may be filled in with cotton-wool, soaked in some of the hot wax-mixture.

‡ Infrequency of dressings has been strongly insisted on by Prof. Ollier (*Rev. de Chir.*, August, 1887; *Annals of Surgery*, November, 1887, p. 424). This most important economy—of pain to the patient, and time to the surgeon—is only to be secured by—(1) Removing

watch for every sign of reappearance of the disease, and to attack it at once.*

After-treatment.—Morphia or laudanum should be used freely at first, if needful. If there be no reason to the contrary the dressings should be left undisturbed for about a week, when an anæsthetic may be given, if needful, to remove the wire if the excision has been a trans-patellar one. If tuberculous foci persist, these must be slit up with a sharp-pointed curved bistoury, and scraped out with sharp spoons. While this may be repeated every two weeks on five or six occasions successfully, the more deliberately the surgeon endeavours to extirpate the disease both in the soft parts and in the bones, the more he treats it as if malignant, at first, the less often will he have to interfere later on.

In about three months, Sir H. Howse's splint may be left off and a Thomas's splint or one of leather carrying a metal bar to resist the tendency to flexion fitted on. Some such fixed apparatus should be worn, in children, for two to three years. If the case be lost sight of, the splint will be removed, with the inevitable result of flexion.

In early life callus-like material is thrown out quickly, and often somewhat irregularly, between the bones, but it is extremely slow in really ossifying. As the quadriceps extensor wastes much more quickly than the hamstrings, even when the patella is retained, the latter muscles keep up their action on the tibia for months, and even for years, until the union is firm. Tenotomy has been advised, and even resection of all the hamstring tendons (Dr. Phelps, *New York Med. Record*, July 21, 1886; *Annals of Surgery*, October, 1886, p. 364). I think, however, that retaining the bones immobile and in good position, securing early healing of the wound, wearing a stiff apparatus, and, whenever practicable, using the trans-patellar method, will best ensure a limb soundly ankylosed in good position. A knee bent later on can be easily straightened.

Causes of Cases not doing well, Failure and Death after Erasion and Excision of the Knee.—1. Inveterate persistence of the disease leading to (a) giving way of the supra-patellar pouch, and the results mentioned at p. 950; (β) to formation of caseating foci, especially at the back of the joint (p. 957), and only to be removed by re-excision or amputation. 2. An unhealthy condition of the bone ends, with caries and chronic osteo-mylitis. 3. Slowly progressive thickening creeping up along the lower end of the femur and down the upper end of the tibia, indicating a persistent tuberculous periostitis. While the latter mischief can be often dealt with by vigorous curetting, all these conditions are grave, and where the vitality of the patient is poor, or when other unfavourable conditions are present, indicate the need of considering the advisability of amputation. While an unpromising limb can often be saved by vigorous

every atom of the disease that can be got at. (2) Providing drainage. The more thoroughly the disease is extirpated, the less need is there to drain; but however completely the disease is removed, many sutures should not be employed, especially at the ends of the wound. (3) Securing as dry a wound as possible.

* It is especially, I think, from neglect of this last detail, that the fact arises that there are almost as many failures from mistakes in the after-treatment as from want of skill in the operation.

curetings repeated two or three times at intervals of a week, the treatment to be aimed at is preventive by thoroughly going over the ground at the first operation. When the surgeon is in doubt as to amputation he should not hesitate to open up the old operation wound, flex the limb, and investigate the condition of the end of the bone, back of the joint, &c. Where after repeated curetting a cavity persists, perhaps with the tibia for its base, time may be saved by "papering" this with Thiersch's grafts, or better, in my experience, by turning in a flap of soft parts. Even where the surgeon cannot be certain that he has extirpated all the bacilli and spores of tubercle, the bringing in thus of healthy tissues will often be found to have a beneficial effect.

FIG. 404.



A case of excision of both knees, two years after the operation, from a patient under my care at the Hospital for Children and Women, sent to me by Dr. A. T. F. Brown, of Rochester. Both knees were the subject of tuberculous disease on admission. One was excised three months after the other.

to the bone-ends being in close contact (two wire sutures were used). A similar case, after hip resection, by Prof. Lücke, is mentioned. Prof. Vogt thought that he would amputate in another case if, after excision of the knee, the limb could not be straightened without close apposition of the sawn fatty bone-ends.

4. Deficient reparative power, leading to bed-sores, emaciation, and hectic. 5. Co-existence or subsequent development of such visceral diseases as phthisis, &c. 6. Surgical scarlet fever. 7. Infective conditions.—For these the surgeon will, nowadays, be, as a rule, entirely to blame. 8. Tetanus. 9. Secondary hæmorrhage.—Another very rare condition. 10. Fat embolism.—This is a still rarer condition, but one which, on account of the interest it excited some years ago, and because it has once, at least, proved fatal, deserves mention here.

The case was that of a child, aged 12, submitted to excision for pulpy disease by Vogt, of Griefswald (*Cent. f. Chir.*, 1883, S. 24). The bones were so fatty as to cut with a knife. Though but little chloroform had been given, and the loss of blood had been slight, the patient died twenty-four hours later with shallow respirations, feeble pulse, and low temperature. Fat embolism of the lungs, extensively diffused, was found post mortem. Vogt considered that this case predisposed to fat embolism. Thus cut vessels were exposed on the sawn surfaces with plenty of free oily matter close by, and unable to escape, owing

11. Shock.—This, though rare, must be remembered. Twenty-one years ago I lost a case from this cause.

The patient was a delicate boy, aged 7, with a large tuberculous knee. As there was no suppuration, no sinuses, nor evidence of much mischief in the bones, I, unwisely as it was proved, tried to save the limb. The child sank a few hours afterwards. Volkmann (*Cent. f. Chir.*, Bd. xii., Heft 9, Feb. 28, 1885; *Ann. of Surg.*, May, 1885, p. 486) draws attention to the need of taking care in children that too much blood is not lost, and that deep narcosis is not too prolonged.

12. Flexion and ankylosis.—The frequency of these and their prevention have already been referred to. In cases occurring after erasion the union is always fibrous, and the limb can usually be straightened with the aid of an anæsthetic and division of the hamstrings (*q.v.*). Great care must be taken not to strain the epiphysial lines. In those cases where backward displacement of the tibia is present as well, the old incision should be opened up, and the uniting material divided with an osteotome. If this fail a partial excision must be performed, no formal wedge being taken away, but the ends of the bone successively chiselled away until the limb can be straightened. But where a much-flexed limb is completely straightened at once, the warning given below must be remembered. After excision the union is usually bony. In the slighter degrees of deformity division of the bony material with a chisel or osteotome usually suffices, the limb being gradually straightened. Where the deformity is more marked, osteotomy of the femur above the joint, and, if needful, the tibia also, is preferable to performing a second excision, or removing a wedge of bone.

As I shall not have space again to refer to this matter of ankylosis of the knee, I would strongly urge caution in rapidly and completely straightening a knee-joint which has long been the seat of bony ankylosis in a bad position. My attention was drawn to this matter in a painful way many years ago.

A girl of 19 had been admitted under my care with bony ankylosis of the knee at a right angle, dating to disease seventeen years before. Finding that I was unable to materially improve the position by subcutaneously sawing through the bony union, I excised the joint and straightened it completely. The foot and leg remaining cold, an anæsthetic was given next day, and the limb put up flexed. The mischief was, however, done. The coldness remained, all pulsation in the tibials stopped, and gangrene evidently threatening, the thigh was amputated, the patient sinking afterwards.*

At the necropsy, osteophytes were found on the posterior border of the tibia projecting backwards, and it was evident that over these, when the limb was straightened, the popliteal vein, a very small one, had been stretched and closed.

ARTHRODESIS.

By the above term is meant the denuding of a joint of its cartilage so as to produce either partial or complete ankylosis, the object being to save a hospital patient with a flail-joint the need of expensive apparatus. The operation was first practised by Albert, of Vienna,

* Just after this another London surgeon published a very similar case. Sufficient attention has not been drawn to this matter. It would have been much wiser on my part, with such dense and old-standing ankylosis, to have put the limb up flexed at first, or to have rectified the position in two stages with an osteotome. I have adopted the step successfully since, in much older patients, with almost as much contraction.

in 1878, and was introduced into this country by Mr. R. J. Jones, of Liverpool, who reported twenty-six cases operated on without mishap in the *Provincial Medical Journal* of December, 1894.

As the knee and the ankle-joints frequently require combined attention, arthrodesis of these two joints is considered together.

The operator aims at partial or complete ankylosis. It is not easy to predict accurately which will occur. Partial ankylosis—ten or fifteen degrees of movement being advantageous for walking purposes—is desired usually at the ankle. Without the removal of much bone it is not easy to bring about a complete ankylosis here. If a partial ankylosis is desired merely, a thin layer of cartilage is gouged away, care being taken that the whole area of cartilage is removed. If the ankle be wholly paralysed, ankylosis should be as complete as possible. If arthrodesis is employed as an aid to tendon-transplantation, the ankylosis is best if partial.

Complete ankylosis is generally desirable at the knee, as partial fixation, with no controlling muscles, inevitably means stretching of the fibrous union. It is necessary, except in very young children, to completely peel the joint of its cartilage, even attacking the patella.

The *indications for arthrodesis* are given by Messrs. Tubby and R. J. Jones ("Surgery of Paralysis," p. 173) as follows: (a) complete paralysis of all the muscles, resulting in a flail limb; (b) complete paralysis of muscles about a joint, resulting in a flail joint; (c) partially paralysed joints, where the deformity is fixed, or where the joint becomes deformed the moment pressure is put upon it; (d) as an aid to muscle-transplantation, where it is necessary to guard against overstretching of newly transplanted tendons, or where these tendons are not strong enough to control the joint.

The *disadvantages of the operation* are—(a) some probable shortening of the limb; (b) the limitation of extension or flexion; (c) the need of a support in certain cases.

The authors do not consider the amount of shortening to be a factor sufficiently serious to lay stress upon. "In reference to the loss of extension and flexion, we must admit that there are circumstances where such a loss may be keenly felt. This is scarcely applicable to the ankle, but markedly so in the knee-joint. Many people with complete paraplegia or monoplegia, who have ample means to renew their supports, will feel acutely the disadvantage of not being able to bend the knee when sitting. In public places the stiff, straight limb has obvious drawbacks. To a working lad, however, it is a great boon to be independent of supports, with their expense and worries, and this independence is not at all compensated by the power of flexion. Such cases must be treated in accordance with their desires, bearing in mind that a patient may quite well know what will suit him best. The argument, however, never obtrudes in the case of the ankle, where, in the rare cases of complete fixation, a tolerable degree of movement is carried on at the mid-tarsal joint."

A painful condition after arthrodesis, when weight is borne on the joint, is comparatively common in adults, but it usually disappears in a few weeks or months.

The writers mentioned above do not recommend arthrodesis in the case of the hip-joint. "It would be difficult to carry it to a successful

issue, and, generally speaking, preternatural mobility at the hip is not so serious a disadvantage. The results at the ankle-joint are better than those at the knee."

As an aid to tendon-transplantation at the ankle (Vol. I. p. 55), arthrodesis has been found by Messrs. Tubby and R. J. Jones very successful. In equino-valgus this is especially the case. Given an ankle with very slackened structures, paralysis of the tibiales, and preternatural mobility, arthrodesis will limit movement of the ankle to a few degrees, combined with the introduction of appropriate tendons into the tibiales or into the periosteum in order to restore the movement of inversion. An operation on similar lines may be needed in equino-varus. In talipes calcaneus arthrodesis of the ankle, combined with shortening of the tendo Achillis, is far superior to shortening of the tendon alone, which is liable to be disappointing from yielding of the shortened tendon.

It is necessary in all cases to prolong the use of apparatus, as it takes a considerable time for the joints to become fixed.

Arthrodesis of the Knee-joint.—The skin having been sterilised and a tourniquet applied, an incision is made across the front of the joint, traversing half its circumference, and curved so as to pass below the lower end of the patella. The flap is turned up, the joint flexed strongly, the semilunar cartilages removed, and with a sharp, short-bladed knife or gouge the cartilage should be peeled off the bones, so as to leave a raw surface over their whole extent. The crucial ligaments may or may not be left. All hæmorrhage having been arrested, the joint is closed without drainage.

Arthrodesis of the Ankle-joint.—This may be performed in one of four ways, according to the circumstances of the case: (1) by a transverse incision across the front of the joint; (2) by a perpendicular incision along the mid-line in front of the joint; (3) by an antero-external incision just external to the tendons of the extensor communis digitorum; (4) by a posterior incision over the tendo Achillis.

In old-standing cases, where the foot assumes the equino-varus position, and where all the muscles are paralysed, the transverse incision across the front of the joint is preferable. The division of the tendons is then of no consequence, and an excellent view is obtained of the joint. If there be any compunction in dividing the tendons they can quite easily be drawn aside, with the exception, perhaps, of the peroneus tertius. If firm union be desired not only all the cartilage, but even some of the bone as well, must be removed. Where some power still remains in the extensors of the toes, a linear vertical incision may be preferred, and so, too, where talipes equinus is present and the astragalus is displaced forwards. The posterior incision is useful in talipes calcaneus, where the joint can easily be reached from behind. The incision is made close to the centre of the tendo Achillis, which is drawn to one side or divided, while the incision is carried down to the bone. The capsule is opened, and the gouging completed. If there be any power in the gastrocnemius, the tendo Achillis must be shortened through the same incision.

Before having recourse to arthrodesis and tendon-transplantation, care should be taken to completely overcome by mechanical means any deformity of the foot or leg. If this be not done, considerable traction

may be needed immediately after operation—a process to be avoided when possible. In spite of the trophic nature of the lesions, wounds heal rapidly and soundly.

In the after-treatment a Thomas's knee-splint is recommended while the patient is in bed, and this should be changed to a "caliper" when walking commences. For the ankle nothing is better than a posterior splint.

My own experience of arthrodesis is somewhat limited, being derived from six cases of the operation in the knee-joint and three in the ankle, in two of which the ankle and knee-joints were operated upon simultaneously.* I have never succeeded in obtaining more than close fibrous union even when the ends of the bone had been actually trephined upon. The knee was exposed by the trans-patellar incision (p. 955), and care was taken not to damage the lateral ligaments more than could be helped; the menisci and the anterior crucial ligament were removed. In the removal of the articular cartilage by gouge, chisel, or a curved, blunt-pointed knife, a good deal has to be done by touch, if the ligaments of the already unstable joint are not to be needlessly weakened. In the case of the ankle-joint I made use of a transverse incision, suturing most of the severed tendons afterwards, and in this joint I consider the insertion of a wire between the tibia and astragalus most advisable, as a means of increasing the stability. In two of the cases thus treated, when seen respectively three and five years later, the wire had caused no trouble.

As in the case of tendon-transplantation (Vol. I. p. 64), too much must not be expected from arthrodesis. In only two of my cases am I able to say with certainty that the result admitted of the patient entirely dispensing with supporting apparatus. The simplicity and uncomplicated nature of arthrodesis justify resort to it in the hope that it will improve the ability of the patient to make use of any remaining power which he may possess. Even when the ends of the bone have been thoroughly exposed—and this is essential—it is difficult to ensure stable bony ankylosis. The conditions necessary for such ankylosis are wanting. In early life, even if small sections of bone are removed with the saw—and no more is permissible for fear of further serious interference with the growth of the already dwarfed and dwindled limb—the surfaces of bone are scant and puny. The rims of cartilage exposed are, relatively, very large. Further, the loss of power over the muscles of the thigh and leg is, usually, advanced and confirmed.

WIRING FRACTURES OF PATELLA.

In the words of Lord Lister, who introduced the operation in 1883, "no man is justified in performing such an operation unless he can say with a clear conscience that he considers himself morally certain of avoiding the entrance of any septic mischief into the wound."

The chief points to consider here are (1) the age of the patient, *i.e.*,

* It is right that I should add that my cases of arthrodesis were performed at a time before tendon-transplantation was in vogue. I thus failed to obtain any of those advantages which may accrue from the combination of the two operations.

up to about forty-five, the state of his tissues and viscera, and his amenability to directions; (2) the amount of separation, *i.e.*, a distance of over half an inch; (3) marked tilting of the fragments backwards or forwards; (4) great distension, as this is an indication, as far as it goes, of laceration of the lateral parts of the capsule; (5) the occupation of the patient: the more active this is, the more it involves work on different levels, the more is operative treatment indicated.

In any case the two sides of the question and the risks should be put before the patient. He should understand that while good results are certainly obtainable by ordinary means, lifelong care will be needed to avoid such strains as are involved in stumbling, especially on going up and down stairs, and he should realise that much of the success of the after-treatment rests with him. As I have stated in the account of fracture of the olecranon, it is well that the patient should have an opportunity of discussing the matter with another who has been operated upon.

The above remarks apply to cases of simple fracture; in compound cases, the need of cleansing the joint by irrigation, &c., is an additional reason for operating.

Operation.—1. I shall first take cases of recent fracture. The rarer ones of older standing are considered at p. 969. The question as to the best time for interference now arises. While several who are authorities recommend operation during the first few hours, I should advise waiting until the third day. My chief reason is that this gives more time for thoroughly sterilising the parts. Owing to its density and rugæ, the skin here is one of the most difficult to deal with satisfactorily. If operation is resorted to at once the vigorous measures required—*e.g.*, in a patient habitually working in dust—may lead to a condition of dermatitis. Boracic acid fomentations, applied at once and continually to remove the horny epithelium here, pave the way for thorough sterilisation. Further, in my opinion, waiting till the third day gives opportunities for a more thorough examination of the patient externally—*e.g.*, for other injuries, the presence of any focus of suppuration, &c.—while it finds him in a better state for the anæsthetic. I admit that this delay may lead to more coagulation in the joint, but this disadvantage I consider a minor one.

Every detail for the securing of complete asepsis having been secured, the parts are best exposed by a flap-incision.* I have generally employed one with its convexity downwards, believing that this best secures the vitality of the flap. The incision commences on a level with the upper margin of the patella, about one inch to one side, passes downwards to a point a little below the level of the line of fracture, where it is carried across the limb and then upwards to a point corresponding to that from which it started. I have not found that this incision in any way interferes with kneeling afterwards, an objection which has led others to prefer a flap with its extremity upwards. A flap-incision has the undoubted advantages of better exposure of the parts, facilitating the dealing with the fragments, the

* An Esmarch's bandage is not needed, and would have the objections of causing oozing afterwards into the joint-cavity, and also of preventing that bringing down of the extensors of the thigh which may be required in cases of wide separation.

removal of clots, and uniting the lateral parts of the capsule, if injured; lastly, where drainage is necessary, it is easily secured.

But, while the flap-incision has the above advantages, it must be remembered that it involves more disturbance of the parts, especially where these have been much contused and where their circulation is not yet re-established. Lord Lister used the vertical incision; Prof. Kocher employs a slightly curved one. In any case the transverse part of the incision should never be opposite the line of fracture, and in marking out and raising a flap care should be taken to secure uniform nutrition and vitality and to interfere with the parts as little as possible. For the exposure of the fragments, removal of any intervening tissue, clearing away of clots, drilling the bones, and passage* of and dealing with the wire, the details given for like treatment of the olecranon (Vol. I. p. 127) should be carefully followed.

By some American surgeons wire has been replaced by absorbable material—*e.g.*, catgut, silk, kangaroo-tendon—thus doing away with any risk of after-trouble with the wire, a risk which is nowadays extremely small. Some have gone farther and advised suture only of the torn periosteum and fibrous tissues (Gibbon, Rodman, *Ann. of Surg.*, June, 1904, pp. 1023, 1026). In a number of cases this has been found sufficient, as there is no risk of the fragments here shifting longitudinally or laterally if the quadriceps extensor be kept relaxed for two or three weeks. The arguments for and against this step appear to me to be as follows: Drilling the fragment is the most difficult part of the operation, and necessarily adds to the amount of disturbance of the parts, and the risk of infection. On the other hand, if the fragments themselves are not wired, the after-rest must be prolonged in order to secure bony union. Instead of the splint being removed in ten days and the patient being up in a fortnight, a period of at least six weeks will be required. During this time massage will, of course, be assiduously employed.

I have no experience of Mr. Barker's method of passing wire around the fragments (*Brit. Med. Journ.*, April 18, 1896). Dr. J. B. Roberts (*Ann. of Surg.*, June, 1904, p. 1027) has employed a simpler method by passing a silk or catgut purse-string suture round the fragments. These are encircled with a suture passed, by means of four punctures, through tendon and aponeurosis. This method does not open the joint, and while not securing such perfect adaptation of the fragments as is secured by wiring, has been followed by satisfactory function.

* While it is well to take precautions here, it probably does not matter much (supposing, of course, that strict aseptic precautions are taken) if the wire is passed within the joint. Lord Lister gives the following aid to making the two drill-holes exactly correspond: "Supposing that on one side the instrument should have come too far down, it may be into the cartilage, we do not regard that at first, but pass the wire through the two drill-holes, and then on that side on which the hole has come too far down, by means of the bradawl we simply chip away a little of the material that is above the wire, until the wire comes to be in a position exactly opposite to the hole on the other side." If, in another case, there is a difficulty in making the drill emerge upon the fractured surface, Lord Lister would advise the withdrawal of the drill and substitution of the blunt end of a needle, and then with a gouge or bradawl an opening is excavated upon the fractured surface, opposite to the other drill-hole, until the needle is exposed; the wire can then be easily passed.

One of Dr. Roberts's patients was able to carry kegs of beer up and down stairs as well as was the case before the fracture. In answer to the objection to such methods that they do not admit of removal of blood clots or fibrous tissue between the fragments, Dr. Roberts argues that Nature will remove the former "by absorption, as she has been doing for years before the open operation was advocated." As to any periosteum between the fragments, this can be removed without opening the joint by elevating the limb so as to relax the quadriceps, and rubbing firmly together the approximated fragments. The "dull crepitus at the beginning of the manipulation will be followed by a sharp bony crepitus as the fragments of periosteum are crowded away."

2. Certain Cases of Old Fracture of the Patella.—This important matter must be taken somewhat in detail.* The chief points here justifying resort to wiring are: (a) Failure of previous treatment, especially in hospital patients. (b) A useless limb, especially in a man whose occupation entails much walking or standing, where the gait is helpless and requires much attention, or where many falls have followed involving serious risk of fracture on the opposite side. (c) Where both patellæ are fractured. (d) Where the patient is young and has many years of active life before him. (e) Where, if not young, the patient is sufficiently healthy. (f) Where enough is known of the patient's habits to ensure his being amenable.

Operation.—The fragments when exposed† are generally found embedded in fibrous tissue, thickened synovial membrane, and old decolorised coagulum. This must be snipped or cut away, and any spirting vessels in the thickened synovial membrane must be secured. A very thin section from each fragment is then removed with a narrow-bladed saw, this needing much caution in the case of the lower one, which is the smaller of the two. If the fragments can now be pressed into close apposition, nothing usually remains save to wire them, but the case is by no means so simple where the bones are widely apart.

Thus, in one of my cases, many years ago, after paring the fragments—these were quite two and a half inches from each other—and after most forcible traction the upper could only be made to descend three-quarters of an inch. Malgaigne's hooks were applied and tightly screwed up, but with no result on the desired approximation. The lateral expansions of the quadriceps were next still more fully divided (cut muscular fibres being seen on the inner side), but the fragments were almost as far apart as ever. As the only alternative to excising the joint (in order to substitute a firm support for the flail-like limb), I now divided partially the rectus tendon, but it was not till the upper fragment was only held by a narrow stout band at its upper and inner parts that it could be brought in apposition with the lower one. The result was excellent. At the present day, elongation of the rectus tendon, performed as in the case of the triceps (Vol. I. p. 129), with division of the lateral parts of the quadriceps, if needful, would be employed.

Owing to the tension, wire must be used in these cases, according to the directions given, Vol. I. p. 127. Owing to the bones being

* Lord Lister goes so far as to consider (*Lancet*, Nov. 3, 1883) that "the ununited case is in every respect worse as a subject of operation than the recent." This is chiefly owing to the wasting of the fragments and their greater separation. Again, in recent cases, there is no need to pare the fragments, for after sponging away of clots the surfaces are ready for coaptation.

† In one case, the skin being dimpled, puckered down, and adherent between the fragments, I had to cut away a piece about three-quarters of an inch wide.

probably degenerated from disuse, the bradawl should be inserted a full half-inch from the fractured surfaces.

In these difficult cases it must be remembered that it is not absolutely necessary to get the fragments into exact apposition. If, after wiring, they come within a quarter of an inch of each other, the limb will be a most useful one, though of course exact apposition is to be desired.*

Where the lower fragment is too small to hold a wire, this may be passed through the ligamentum patellæ, as has been done by Lord Lister (*loc. supra cit.*) and Mr. Teale (*Brit. Med. Journ.*, June 9, 1883). One wire would appear to be sufficient. Though this unites the centre of the fragments exactly, a very slight interval remains at the edges, but does not interfere with an excellent result.

Before the wire is hammered down, if this course is decided upon, the surgeon must decide as to **drainage** of the joint. When the operation has been difficult, if it has involved much separation of adhesions and interference with the parts, if there be troublesome oozing, drainage should be employed, either by gauze from the ends of the wound, or through the wound to the most dependent part of the joint at the outer side (Lister), dressing forceps being thrust here through the joint and soft parts, cut upon it, and a drain drawn through. The wound is then united and dressed. As soon as the wound is healed, every pains must be taken, by massage, &c., to improve the atrophy of the quadriceps. Healing should be complete in two weeks.

The question of **passive movement** now arises. Usually, in two to three weeks after the operation the patient may get up and begin to use the limb (with the aid of two sticks at first), flexion and extension being diligently practised. Unless the joint is very stiff, massage, friction, and gentle persevering movement, aided by time and patience, will be sufficient. If an anæsthetic is given, movements must be made cautiously, as the patella has been refractured on this occasion more than once.†

Difficulties in Wiring the Patella.

1. Atrophied surfaces of the fragments, making it difficult to refresh them satisfactorily. 2. A very small lower fragment. 3. Fragments embedded in very firm fibrous tissue, fascial, periosteal, and synovial, or old coagulum.—This condition will prevent satisfactory apposition unless the intervening tissue be all removed. In a very interesting case recorded by Mr. O. Ward (*Lancet*, Nov. 1, 1884) it was found, on exploring the fragments, that the capsular tissues torn off the lower fragment remained attached above, and hung like a flap between the fractured surfaces, effectually preventing their apposition. It is suggested that some such complication may, in many cases which have

* In a case of Mr. Wheelhouse's (*Brit. Med. Journ.*, June 9, 1883) the fragments, originally an inch and a half apart, could only be brought within half an inch of each other; an excellent limb resulted.

† In one of Lord Lister's cases (*loc. supra cit.*), passive movement being employed with "considerable force" four weeks after the wiring, the rigid quadriceps not yielding, the wire gave way, and the cicatrix (a long longitudinal one), which had healed save where the wire projected, opened. The joint was at once washed out antiseptically, and, six days later, some coagula were removed, and the old wire retwisted. An excellent limb was the result.

been treated in the usual way, cause the fragments to fall apart as time goes on. This is the view held by Sir W. Macewen (*Lancet*, Nov. 17, 1883; *Ann. of Surg.*, March, 1887, p. 178), who collected thirteen cases of transverse fracture of the patella, in which portions of soft tissue intervened between the fragments in such a manner as to render osseous union an impossibility. 4. A contracted, rigid quadriceps (p. 969). 5. Indipping skin (p. 969). 6. Multiple fragments.—This may cause much difficulty, especially if it is the lower and usually smaller fragment which is comminuted. If the lower fragment is not large enough to bear wiring, the wire may be passed through the ligamentum patellæ. Where the fracture is multiple, the smaller fragments may first be united by fine wire, and then by stouter, to the larger one. But where they are found to be much loosened in their periosteal covering, it will be wiser to be content with carefully uniting the torn periosteum, and enforcing longer rest afterwards.

Causes of Failure, or Trouble afterwards.—These are mainly: 1. Infective conditions (p. 972). 2. Trouble with the wire.—This rarely occurs where the wire has been well hammered down, some adjacent fibrous tissue drawn over it, and the flap-incision made use of, or a transverse one lying below the site of the wire. In one of my cases of old fracture the patient returned, nearly a year later, with great tenderness over the wire. She was extremely thin, and had knelt early and much. On removing the wire I found that I had made three or four half-twists instead of two. In another case, operated on by the late Mr. Davies Colley, a small bursa, the size of a thrush's egg, containing fluid, formed around the twist. This, made with the greatest symmetry, consisted of four half-twists. Where it is necessary to remove the wire, this may be done, with the aid of eucaine, by a small incision over it. The wire is first untwisted and straightened; one end is next cut off short, and the other grasped in dressing forceps and wound round these. It is then extracted without jerking. If this step be required before a period of six or eight weeks after the operation, care not to break down the union will be needful.* 3. Inability to bring the fragments together in long-standing cases.—Mr. Turner (*Clin. Soc. Trans.*, vol. xviii. p. 41) mentions a case in which the operation was abandoned, as it was found impossible to get the fragments together after wiring them. The patient was "no better and no worse" eventually. 4. Necrosis of a fragment.—This is a complication rather than a cause of failure. It is especially likely to occur after severe compound fractures in which the periosteum was much injured at the

* The following show that the wire may occasionally excite irritation and lead to serious results. Sir W. Macewen (*loc. infra cit.*) mentions a case which came under observation three months after suture of the patella, with acute suppurative arthritis of the joint and ulceration of the cartilage. A probe passed through a sinus detected the wire surrounded by carious bone. The twist was still intact, but the loop was loose, the bone having become inflamed, softened, and ulcerated. Excision of the joint was required. This shows that occasionally the wire may excite irritation, and thus lead to serious results. Mr. Turner (*Lancet*, 1887, vol. i. p. 572) records a case in which Mr. M. Robson, of Leeds, had wired an ununited fracture of the patella, three gold wires being employed. The patient, an epileptic, probably injured the knee repeatedly, the wires worked out, and the knee-joint became acutely inflamed, requiring free incisions and drainage.

time of the accident. This happened with an upper fragment in a case of Dr. G. R. Fowler's (*Ann. of Surg.*, 1885, p. 248). About three months after the wiring, this fragment, about the size of a walnut, was removed. It was now found that "the joint was perfectly closed by a thick fibrous capsule underlying the necrosed portion, connected to the upper margins of the now firmly united two lower fragments, and forming a strong bond of union between the quadriceps above and what remained of the patella below." The resulting limb was useful, with considerable movement at the knee-joint. 5. With the increasing frequency with which this operation is resorted to, there is another cause of failure, partial at least, for which surgeons must be prepared in patients no longer young, and that is a condition allied to osteo-arthritis, set up by the injury, and, in part, by the wiring. A patient of mine, aged 42, in whom the healing and movements regained had been most satisfactory, returned six weeks later on account of pain and increasing stiffness in the joint. The wire was giving no trouble whatever, but both to the feel and the ear the joint gave marked evidence of osteo-arthritis; there had not been time for the occurrence of lipping.

REMOVAL OF LOOSE BODIES* FROM THE KNEE-JOINT.

This is another instance of an operation rendered safe and simple by the teaching of Lord Lister. Removal by **direct incision** will therefore be alone described here.

Operation.—The parts should be kept at rest and most scrupulously sterilised for some days. I will draw attention to the danger in opening a large and complicated joint like the knee, even greater care being needed here than in the case of the peritoneal sac owing to the smaller power of resistance possessed by the synovial membrane. Gloves should be worn here, and as in the previous and next operations, the fingers should be repeatedly dipped in some antiseptic solution, and any ligatures which may need tying within the joint should be fastened by forceps. Owing to the great mobility of some of these bodies, it is well to harpoon them with a sterilised needle, if possible, at the beginning of the operation. The joint is then deliberately and sufficiently opened. Where the body cannot be found a free incision must be made at its most usual site, or the angular incision mentioned below or a flap with its base at one side of the joint may be employed. Some advise that the incision through the skin and that into the capsule should be in different planes to guard against possible subsequent infection from

* The following classification may be useful to a surgeon about to operate for one of these bodies: (1) A thickened or indurated synovial fringe which has become pedunculated and perhaps detached; (2) a fibro-enchondroma originating in those cartilage cells which are naturally found in the synovial fringes; (3) a portion of articular cartilage detached by injury. Seven years ago I removed one of these loose bodies from the knee-joint of a railway porter who came to me for synovitis, with the history that the attacks dated from the time when a cask which he was moving had slipped and struck obliquely the inner side of his right knee-joint (*Lancet*, 1889, vol. ii. p. 363); (4) a bit of cartilage may, after injury, gradually become detached by a process of quiet necrosis (Paget); (5) blood effused into a synovial fringe; (6) a mass of fibrine; (7) a detached osteophyte; (8) Mr. H. Marsh (*Dis. of Joints*, p. 182) mentions a case of Mr. Shaw's, in which a loose body on removal was found to contain the point of a needle.

without. In any case the incision through the synovial membrane must lie at a sufficient distance from the margins of the patella and tibia to allow of this membrane being independently sutured. In a very few cases where a loose body is known to exist, but cannot be found, or where it is multiple, extensive incisions, *e.g.*, trans-patellar (p. 955), or turning down a flap of the quadriceps and capsule, have been employed. In difficult cases a loose body may be brought into view by putting the joint through its different movements, or by flushing it out with sterile saline solution. These steps should always be taken before making free incisions which are likely to interfere with the joint's functions, or before even putting a finger into the joint. In some cases a second smaller incision may be the wisest step.

In the case due to injury (footnote, p. 972), on cutting freely into the joint, I came down upon a tiny pedunculated body attached close to a healed depressed gap in the rim of the internal condyle. As it was certain that this body could not be the offending one, the portion of detached articular rim was only found after a prolonged search in the extreme upper end of the supra-patellar pouch. The patient made an excellent recovery, and resumed his work as a South Eastern Railway porter. This case proves conclusively that the late Sir G. M. Humphry was wrong in his statement that the articular cartilages are too strong and too well protected for any fragment to be dislodged save by disorganising violence.

Where one body has been removed the surgeon must make certain that no others are present. Mr. R. Jones (*loc. infra cit.*) thus emphasises this point: "I have on three occasions had to open up a joint a second time to remove bodies evidently present from the first."

All hæmorrhage having been arrested, the joint rendered absolutely dry, the wound is closed in two layers as advised below. A sterilised white bandage having been applied from the toes to mid-leg, the dressings are firmly bandaged on with uniform pressure. Where the search has been prolonged, the parts interfered with, many bodies removed, or when there is likely to be oozing, drainage must be provided by sterilised gauze, horsehair, or a small tube. The after-treatment is the same as that indicated at p. 970.

DETACHMENT OF A FIBRO-CARTILAGE AND OTHER FORMS OF INTERNAL DERANGEMENTS OF THE KNEE.

Before the question of operative interference is considered the following remarks, the outcome of exploration of nineteen cases, may be useful. I shall divide the cases into two groups: (A) Where a fibro-cartilage, far more frequently the internal,* has been injured, and perhaps displaced; (B) where other conditions are present. A. These fall into two classes, the typical and atypical ones.

* The greater frequency of displacement of the internal fibro-cartilage is due to its being more fixed and, therefore, to its feeling strains more, especially strains of the internal lateral ligament, as when the flexed knee-joint is suddenly rotated outwards. The internal fibro-cartilage, in addition to its attachments by the coronary and transverse ligaments, is fastened all along its convex border to the inside of the capsule, and to the internal lateral ligament, strongly. The external fibro-cartilage, on the other hand, is more weakly attached to the capsule, especially opposite to the popliteus tendon, and has no attachment to the external lateral ligament.

(1) In the latter, not infrequently, though the fibro-cartilage may have been much injured, there is little local external evidence, and it is impossible to tell accurately what the exact condition is; at the operation, marked mischief is found. (2) Where a fibro-cartilage has been undoubtedly injured, it is not always easy at the time of operation to be certain as to the nature of the injury. In many cases where the fibro-cartilage is detached at either end, or still attached but torn through its centre, with one or more slips torn off, the mischief is obvious. But this is not so in other cases, *e.g.*, where a fibro-cartilage, which there is every reason to believe to be the cause of the trouble, is found to be *in situ*. Here its mobility must be determined; if an aneurysm-needle can be easily slipped under the fibro-cartilage from end to end, and, still more, if it can be readily hooked forwards or folded backwards into the joint, the indications for its removal are obvious—for I am not an advocate of suture (see below)—but there are other cases not so easily cleared up and in which a thoughtful surgeon finds it difficult to be certain as to the exact degree of mischief present, and this uncertainty is increased by the limited wound which it is usually advisable to make. B. Often much less typical cases, where other conditions than injury to a fibro-cartilage are present. Diagnosis here is often at fault; even with the great increase of these operations, we are not yet familiar with all the different conditions which may more or less closely resemble a displaced fibro-cartilage. First of course are the “loose bodies” of which I have written at p. 972. These may simulate the results of injury to a fibro-cartilage very closely. Of the other much less obvious conditions which may cause pain, recurrent effusion, perhaps locking and a more or less defined swelling, and cripple the joint to a varying degree, I shall mention a few with which I am familiar. Time will bring to light others which I have overlooked. When a knee-joint is opened and the fibro-cartilages are found to be normal in position and fixity, where no loose body is present, the first condition to think of is (*a*) an altered condition of the synovial fringes, especially the pads, alaria, and mucosum.

I have had three cases in which I believed this condition to be the cause of the trouble. All were young adults. In none had locking been a prominent feature. On exploration of the synovial recess between the tibia and patella, a large reddish yellow fringe with its margin much thickened in places was found. In two of the cases it was easily shown that the fringe passed during certain movements of the joint between the articular surfaces of the femur and tibia. In two of the cases the synovial membrane appeared generally injected; in none of them was any effusion present. The fringes were cut away, a ligature being applied in one case, and drainage employed. All made good recoveries, but I have not had the opportunities needful to enable me to state whether the results were permanently good. Microscopical examination showed an ordinary synovial fringe, chronically inflamed, and with ecchymoses of different dates. Prof. Annandale, who did most useful pioneer work in the removal of displaced fibro-cartilages, was, I believe, the first to call attention to these bodies (*Brit. Med. Journ.*, 1887, vol. i. p. 320). Dr. C. P. Flint, of New York, has recorded three cases in which he operated (*Ann. of Surg.*, September, 1905, p. 445). Excellent illustrations accompany the paper.

Mr. R. Jones, of Liverpool (*infra*, p. 976), writes: “Hypertrophy of the synovial villi is frequently confused with a damaged semilunar. The condition is much more common than is usually suspected, and I have frequently met with it when exploring joints.” On one occasion,

failing to find any injury to the semilunar in a case with typical symptoms, Mr. Jones, on enlarging his incision, found a ligamentum alarium actually detached and lying in the intercondyloid notch. Its removal resulted in a perfect recovery.

(b) While the semilunar cartilage is normal in position and its attachments, it has been bruised, and the adjacent head of the tibia is the seat of osteitis and periostitis. (c) The parts are normal save perhaps for some injection of the synovial membrane. While making due allowance for my faulty diagnosis and the limited access for exploration, I am convinced that such cases do occur in neurotic patients, as in some other conditions submitted to frequent operation at the present day. On this subject and the varied causes of recurrent effusion into the knee-joint, my readers should consult a most instructive article by Sir W. Bennett, K.C.V.O. (*Lancet*, Jan. 7, 1905). Before leaving this part of my subject I will add two cautions, one, that in cases where only injection and other slight changes in the synovial membrane are all that can be found it will always be well to bear in mind the possibility of early tuberculosis.* The other is one to which I have drawn attention at p. 972. This operation, especially if followed by stiffness and the treatment necessary to meet this condition, may light up, especially in patients no longer young, a tendency to osteo-arthritis.

Indications for Operation.—The chief of these are: (1) Confidence on the part of the surgeon that, as regards both himself and the patient, he can secure an aseptic result throughout; (2) failure of palliative treatment, especially in recurrent cases; (3) cases of especial expediency, *e.g.*, where the employment entails especial risks, where the patient is likely to be remote from surgical aid, or where a future career or some particular pursuit will be interfered with. Thus in a case of Mr. F. J. Steward's—

The patient—a student—had suffered for over seven years from repeated displacement, latterly brought about by quite trivial movements, such as stepping off a kerb. The operation was performed in August, 1900; the cartilage, which had been completely torn from its anterior attachments, being removed. In January, 1902, the patient was playing football regularly, and did not notice the slightest difference between his two knees.

Mr. R. Jones, of Liverpool, gives the indications for operation better thus:—"In the first place, *I refuse to operate in any case I see early, the subject of a first derangement. I discourage operation in those recurrent cases where the symptoms are transient and not followed by irritation of the joint. I strongly urge operation in those cases where a recurrent displacement is at times followed by acute symptoms. I advise it in all recurrent cases where a strenuous athletic life is a means of livelihood or a physical necessity. I think operation absolutely imperative in the case of men who work in dangerous places.*" As "of two cases, carefully watched, each refusing operation, one resulted in rheumatoid and the other in tubercular change," Mr. Jones advises

* I refer especially to those cases where the synovial membrane is found generally injected, and some effusion is present. It is noteworthy that in one of Dr. Flint's cases the fringe removed showed the existence of tuberculosis. A generally villous or papillary synovitis would be, obviously, most suspicious.

"that this danger should be kept well in view, and that patients with either a tubercular or rheumatoid diathesis subject to recurrent derangement should early be persuaded to have the exciting cause removed."

Mr. Jones's paper (*Clin. Journ.*, May 9, 1906) only came into my hands when these sheets were passing through the press. It is well worthy of a most careful study from the writer's well-known experience, proved at many points by the lucid practical details, especially where he is dealing with the difficulties which are present in the diagnosis and treatment of "certain derangements of the knee."

Operation.—The area having been carefully sterilised and the strictest precautions taken in every way (p. 972), an angular incision is made—I shall take the case of exploration of the internal fibro-cartilage—the first part nearly three inches long, three-quarters of an inch from the inner border of the patella, vertically downwards to the interval between the femur and tibia, and then inwards as far as the internal lateral ligament. The reason for placing the incision at the above-mentioned distance from the patella is explained later; the most important internal lateral ligament is to be interfered with as little as possible. The capsule, together with the synovial membrane, is now incised in the same line, and all hæmorrhage carefully arrested. The condition of the fibro-cartilage is now investigated, with the joint flexed and extended. Many of the various degrees of damage which it may have received and several of the other conditions which may be present have already been alluded to. Where the fibro-cartilage is much damaged its removal is of course indicated by dragging it forward and snipping it away with curved blunt-pointed scissors. Where its condition is more doubtful*—i.e., where it is only partially frayed—I am of opinion that its removal is the wisest step. In cases of doubt the longitudinal incision must be converted into a flap, or a second incision made on the opposite side. Attempts to suture the fibro-cartilage are never advisable. This procedure is difficult: the sutures are very likely to give way,† and the more prolonged rest now needed—three or four weeks instead of ten days—will very likely lead to after-stiffness. The wound is dealt with, and the after-treatment conducted, as indicated at p. 970. Suture of the synovial membrane with separate buried sutures of sterilised silk is most important here: it promotes early union of the deep parts of the wound, thus at once facilitating the regaining of movements, and shutting out the risk of after-infection. For the insertion of these sutures the synovial membrane must not be divided close to the patella, or there will be no edge to take up.

The case that follows illustrates the liability of clamps to fail suddenly after a prolonged period of usefulness, and the presence of osteoarthritis, in a very marked degree, in a young subject.

R. C., æt. 35, had had repeated displacement of his left fibro-cartilage since a wrench of his knee when 17 years old. A clamp gave great relief for some time, but latterly this

* In all doubtful cases, Mr. Jones's advice (p. 977) must be remembered as to the possibility of more than one mechanical factor existing in a joint.

† Mr. M. Moullin (*Lancet*, 1895, vol. i. p. 1233) mentions two cases in which the displacement recurred after suture. In his words, "sutures and adhesions cannot make it stronger than it was before it was hurt, unless they fix it so that it is completely rigid; and if it gave way before, it will give way all the more easily a second time if exposed to a similar strain."

ceased to be any safeguard. In April, 1894, I opened the knee-joint by a vertical incision three inches long, placed about an inch from the inner margin of the patella, and beginning opposite its centre. The first thing to come into view when the joint was opened was the inner condyle, with its margin converted into a huge lip, everted and raised and covered with a network of many minute vessels. The head of the tibia, as far as seen, presented the same appearance along its articular rim. The internal fibro-cartilage was found detached from its connections to the tibia and carried up with the femur. It was thin, flaccid, and limp, flattened out, its circumferential border having lost its thickness and convexity. No bleeding followed on snipping through its posterior attachments. The "lipping" of the cartilage on the femur and tibia was rounded off with a metacarpal saw, some sessile growths of the synovial membrane were snipped away, and two small osteophytes removed from the articular surface of the patella. The inner aspect of the joint was carefully dried out with aseptic sponges, and, as much oozing was expected from the sawn surfaces, a drainage-tube was passed into the upper cul-de-sac and brought out through the wound. The wound healed quickly; a month later the patient could walk across Hyde Park, but it was not till nearly six months after the operation that flexion and extension were completely restored, and the patient could say that there was "not much to choose between the two knees." I saw him five years after the operation; he could then use the lower limbs with equal freedom, and the movements of the left knee were quite smooth. He was able to walk, ride, and shoot with entire comfort.

A case brought by Mr. Lockwood before the Clinical Society (*Trans.*, vol. xxvii. p. 133; *Lancet*, 1894, vol. i. p. 673), where twenty-one months had elapsed since the operation, emphasises the importance of the patient not taking liberties with the joint for some time. This is a point liable to be neglected by young adults after rapid healing of the wound.

The left knee had, after an injury, been liable to become locked under circumstances which rendered the patient's occupation, that of an engineer, dangerous. Though nothing could be felt externally, when the joint was opened the internal fibro-cartilage was found to have its anterior third torn up from the tibia. This portion was cut away, and the remainder sewn down to the tibia with silk sutures. The patient made a rapid recovery, but neglecting the advice given not to play tennis or football for a year, had synovitis with considerable effusion after taking violent exercise. Later on he reported that for walking, riding, and swimming the knee was as good as the other. Exercises involving any risk of twisting the joint he had avoided.

In closing this subject I cannot do better than quote Mr. Jones's article (*loc. supra cit.*, p. 976) on the possibility of failure of operation: "Is operative treatment invariably successful? The answer is emphatically, No. In the great majority of cases a perfect recovery may be predicted; in a certain small percentage the symptoms recur. The recurrences were far more numerous some few years back, when the cartilages were sewn to their tibial attachments." In other cases "it will be discovered that the so-called recurrence is due to an overlooked accessory factor in the production of the symptoms of derangement." Mr. R. Jones illustrates this by two cases:—

In one the anterior half of a torn external semilunar had been removed. Slipping again occurred within a month, and, on opening the joint on its inner side, Mr. Jones found a small fibrous nodule floating by a thin pedicle.

In the other case the anterior part of the internal semilunar had been found abnormally free and removed. For some months normal function remained restored. The troubles then reappeared, with pain, referred again to the inner side of the joint. "I followed the line of the old scar and searched for a cause. I was almost closing the wound, when internal rotation of the tibia dislodged a loose body."

CHAPTER V.

OPERATIONS ON THE POPLITEAL SPACE.

LIGATURE OF THE POPLITEAL ARTERY. — MATAS'S OPERATION FOR ANEURYSM.

Indications.—Extremely few. i. Stab or punctured wound.—Here the surgeon would only resort to ligature (1) if pressure (p. 926) was unsuitable; (2) if suture (p. 917) was found impossible; (3) if the patient insisted on running the risk of gangrene; (4) it would be well, if possible, to get leave for immediate amputation if the vein was found injured also, and beyond remedy by suture. ii. In some cases of ruptured popliteal artery it will be right to explore and see if any other complication exist beyond the rupture of the artery.* If there is no injury to the vein, nerves, or the joint (a very unlikely contingency), the rupture should be treated by Murphy's method of resection (p. 917), if possible, and, this failing, by double ligatures. The surgeon must afterwards be prepared to amputate through the lower third of the thigh on the first sign of gangrene appearing. The operation of ligature of the popliteal artery is extremely difficult here, owing to the depth of the vessel, the strong fascia, the amount of coagulated blood, and the infiltrated, oedematous condition of the parts. Primary amputation will, as a rule, be required in cases of ruptured popliteal artery, especially where skilled assistance and facilities for aseptic treatment are not at hand. A free incision will enable the surgeon to investigate the amount of injury, and at the same time will relieve tension if an attempt be made to save the limb. This incision may form part of the amputation (p. 946). iii. The artery has been wounded in the course of an osteotomy of the lower end of the femur. In such a case the vessel should be reached by the incision shown in Fig. 406.

EXTENT.—From the opening in the adductor magnus to the lower border of the popliteus.

GUIDES.—*Behind*: A line drawn from just inside the inner hamstrings above to the centre of the lower part of the popliteal space. *In front*: The tendon of the adductor magnus.

RELATIONS (in the popliteal space):

BEHIND.

Skin; fasciæ; small sciatic nerve above; short saphena vein and external saphena nerve below; fat; glands.

* Poland, *Guy's Hosp. Reports*, third series, vol. vi. p. 294.

Semi-membranosus above ; gastrocnemius, plantaris, soleus, below.

Internal popliteal nerve ; popliteal vein, outside above, inside below, exactly over the artery in the centre of the space.

Branch of obturator above.

OUTSIDE.

Biceps above ; gastrocnemius and plantaris below.

Popliteal artery.

INSIDE.

Semi-membranosus above ; gastrocnemius below.

IN FRONT.

Femur.

Posterior ligament.

Popliteus.

Collateral Circulation.

ABOVE.

Anastomotica magna, superior articular, descending branch of external circumflex.

with

BELOW.

Inferior articular, and recurrent from anterior tibial.

Operations (Figs. 405, 406).—The artery may be tied in three places. A. At the upper part of the popliteal space. B. At the lower part of the popliteal space. C. *From the front*, at the inner side of the limb. For the sake of experience, all should be practised on the dead body.

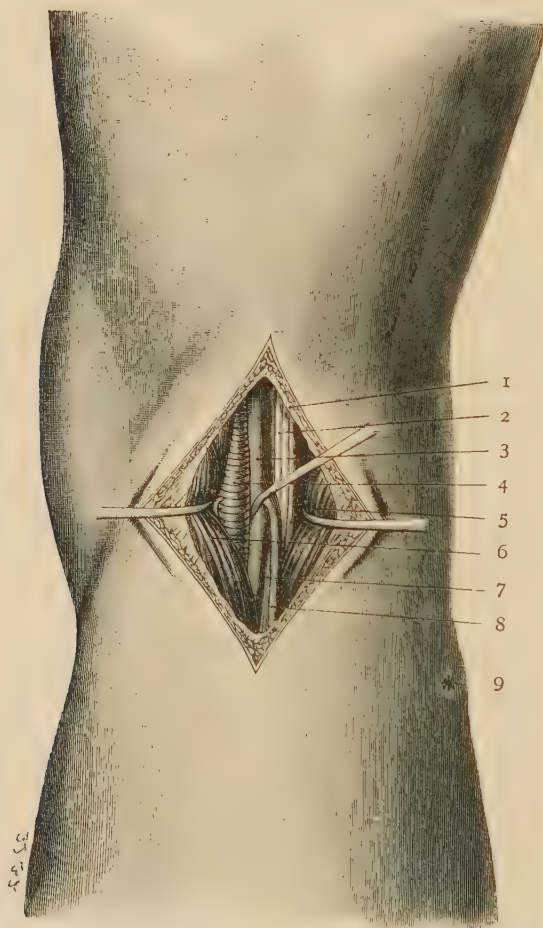
A. At the Upper Part of the Popliteal Space.—The patient being rolled two-thirds on to his face, and the limb at first extended, a free incision three inches and a half long is made, in the line of the vessel, along the outer margin of the semi-membranosus, and then downwards and outwards to the centre of the space. The small sciatic nerve, if seen, should be drawn to one side ; the deep fascia is then freely opened up, and the pulsation of the artery felt for at the outer margin of the semi-membranosus. The nerve is generally seen first, and this and the vein are to be drawn to the outer side with blunt hooks. The needle should be passed from the vein. A good deal of loose fat is usually in close contact with the vessels, and is liable to be a source of trouble wherever the artery is ligatured, especially in the dead subject.

B. At the Lower Part of the Popliteal Space (Fig. 405).—The limb being in the same position, an incision four inches long is made, in the line of the artery, from the centre of the popliteal space to the junction of the upper and middle thirds of the back of the leg. The external saphena vein and its nerve being avoided, the deep fascia is freely opened and the limb flexed. The exact interval between the heads of the gastrocnemius is next sought for. The following structures may now be met with overlying the artery, and must be drawn aside—viz., the plantaris, the sural arteries which run down on the vessel, and the communicans tibialis nerve. The popliteal vein now lies to

the inner side, together with the popliteal nerve, which is superficial to it, if this has not given off its branches. These structures should be drawn to either side, and the needle passed as is convenient.

C. **From the Front, at the Inner Side** (Fig. 406).—This operation

FIG. 405.



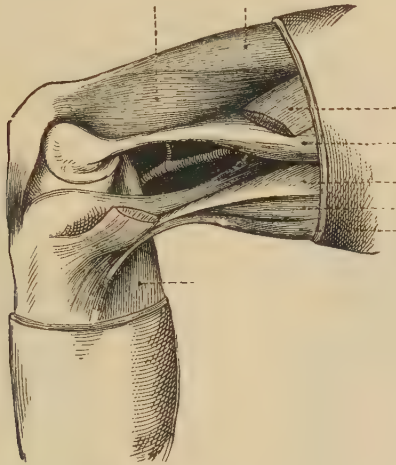
Ligature of the popliteal artery. 1, Deep fascia. 2, Internal popliteal nerve. 3, Popliteal vein. 4, Popliteal artery. 5, Outer head of gastrocnemius. 6, Inner head of gastrocnemius. 7, Communicans tibialis. 8, External saphenous vein. 9, Head of fibula. (Kocher.)

might be useful in cases where hæmorrhage recurs after osteotomy at the lower end of the femur (p. 1071).

The following account is taken from Sir Wm. MacCormac (*Ligature of Arteries*, p. 110): "Flex the knee and place the limb on the outer side. Make an incision three inches long immediately behind and parallel to the tendon of the adductor magnus downwards from the junction of the middle and lower thirds of the thigh. Divide

the skin, superficial and deep fasciæ; avoid the long saphenous nerve; seek the tendon of the adductor magnus; draw it forwards and the hamstring tendons backwards. The artery will then be found sur-

FIG. 406.



Relation of parts in ligature of the popliteal from the front at the inner side.
(Esmarch and Kowalwitz.)

rounded by fatty areolar tissue. The nerve and vein do not necessarily come into view, being on the external aspect of the vessel."

MATAS'S OPERATION (Figs. 407 to 420).

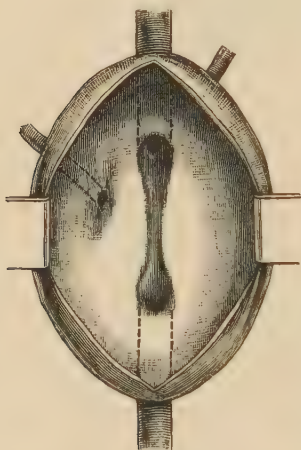
This original method of treating aneurysms, thought out and confirmed in value by four successful cases, will be found in the *Trans. Amer. Surg. Assoc.*, 1902, p. 396, and *Ann. of Surg.*, February, 1903 (Figs. 407 to 420). The sac is not extirpated or interfered with, except so far as is needed to empty it and freely expose its interior; no ligatures are applied to the main artery, and the circulation in the sac is arrested and hæmorrhage prevented by suturing the arterial orifices found in the sac. The sac is obliterated by sutures which infold it, aided by plastic effusion from the intima.* There is but little disturbance of the sac or of its vascular relations; the collateral circulation is not interfered with. Dr. Matas considers his operation applicable to all aneurysms, whether sacculated or fusiform, whether idiopathic or traumatic, in which provisional hæmostasis can be secured. In true sacciform aneurysms with a single orifice this operation will allow of obliteration of the aneurysm without the lumen of the vessel being obstructed, the risk of gangrene being thus obviated. Dr. Matas considers arterio-venous aneurysms and diffuse hæmatomata of recent origin better suited to arteriorraphy (p. 919).

* Dr. Matas points out that, while in large and old aneurysms the endothelial intima will be largely lost, the orifices and adjacent areas—the parts chiefly concerned in the suturing—will retain the characters of this layer.

The following are the steps of the operation as applied to peripheral aneurysms of the larger arteries.

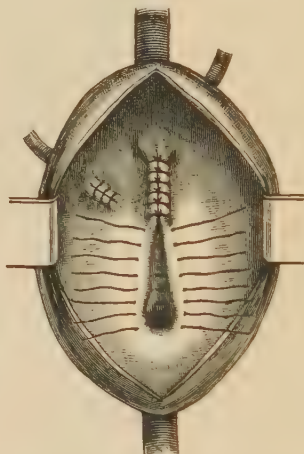
1. *Prophylactic hæmostasis*.—This is effected by an Esmarch's bandage; by exposing the artery near the cardiac end of the aneurysm and compressing it by a loop held by an assistant, or by pressure at this spot by the finger of an assistant, the vessel being protected by a pad of sterile gauze; or by a clamp such as Crile's (vol. i. p. 763). Dr. Matas prefers a silk traction-loop, as it is always at hand. In cervical aneurysms the artery should be controlled, if possible, on both sides of the aneurysm.

FIG. 407.



This shows the interior of a large aneurysmal sac of the *fusiform* type exposed by retraction. The two openings lead respectively into the parent trunk on the cardiac and peripheral sides, and the groove between them represents the continuity of the arterial walls blending with the aneurysmal walls. The orifice of one collateral branch originating in the sac is shown, and another opening, near the orifice of communication on the cardiac side, into the main trunk. (Matas.)

FIG. 408.



The orifices in the aneurysmal sac are shown in process of obliteration. The first plane of sutures may be made with fine silk, but chromicised catgut is preferred. The sutures are inserted very much like Lembert's sutures in intestinal work; the first plane should be sufficient to secure complete hæmostasis. The orifice of the collateral vessel on the left upper side of the sac is shown closed by three continued sutures. (Matas.)

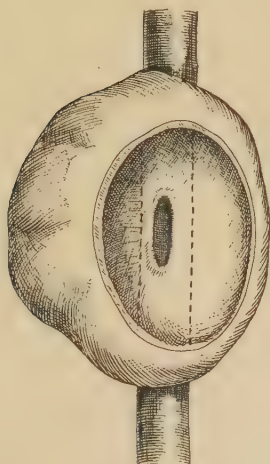
2. *Exposure of the sac*.—When all pulsation has been absolutely arrested, an incision is made down to the sac, so as to expose it from one end to the other. When the aneurysm is deeply situated, the more superficial portion of the sac—but no more—should be exposed by careful dissection in case any important structures are adherent to this surface.

3. *Opening and evacuation of the sac; recognition of its type, the number of openings into it, &c.*—A free longitudinal incision is next made through the whole length of the sac, and the contents evacuated so that the interior is freely exposed to view, the edges being well retracted. If it be a *fusiform* aneurysm two large openings are usually seen at the bottom of the sac, separated by an intervening space of

variable length, frequently marked by a shallow groove representing the floor of the artery (Fig. 407). If the aneurysm be *saciform* (Figs. 409 to 411), the opening will be single, of variable size and shape. In *fusiform* aneurysm, as the continuity of the artery cannot be restored, the object of the sutures is to seal the openings into the vessel for the purposes of hæmostasis and obliteration of the sac. In the *saciform* variety it is often possible to close the opening without obliterating the lumen of the vessel (Figs. 411, 412, and 418).

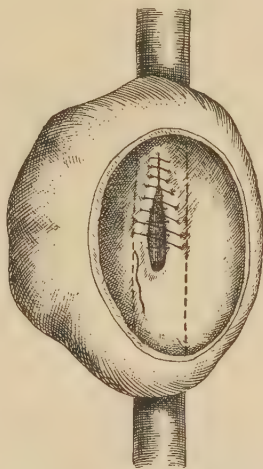
A. *Treatment of fusiform aneurysms.*—The sac having been emptied and the two main openings identified, the next step is to discover the openings of any collaterals,* which, if not carefully

FIG. 409.



Saciform aneurysm with one orifice of communication with the sac. It is possible in this class of cases to close the orifice by suture without obliterating the lumen of the artery, and without interfering with the circulation in the main artery. (Matas.)

FIG. 410.



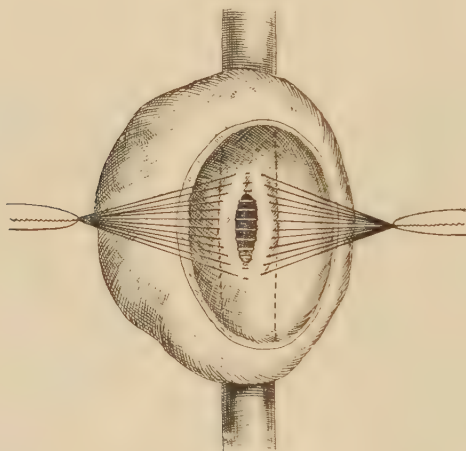
Saciform aneurysm opened. The dotted lines indicate the relations of the main artery to the sac and orifice of communication. The closure of the orifice with a continued suture is shown. (Matas.)

sutured, would give rise to troublesome hæmorrhage. Such bleeding, according to Dr. Matas, only occurs when the circulation in the sac is controlled by a traction-loop or other contrivance, and not by general circular constriction at the root of the limb. When it occurs, such hæmorrhage is readily controlled by pressure applied by the finger or sterile sponges over the openings until these are closed by rapid continuous sutures (Fig. 408). The "toilet" of the sac is then completed by scrubbing the intima gently and thoroughly with gauze soaked in sterile solution, so as to clear away all clots and prepare the lining membrane for prompt plastic reaction when the surfaces of the sac are brought into apposition.

* Such openings of collaterals are more likely to exist in fusiform aneurysms, in which a larger area of arterial wall is involved. (Matas.)

4. *Closure of the aneurysmal orifices in the fusiform type of sac* (Figs. 407, 408, and 417).—The tissues adjacent to these orifices are usually strong and resisting and hold sutures well. The material used may be silk, chromicised catgut, or the finest kangaroo-tendon; Dr. Matas prefers catgut. The needle should be round and fully curved. The continuous suture will usually be found the most rapid and effective. The number of sutures will depend upon the size of the opening to be closed. Eight to ten to the inch are more than sufficient. In closing the larger openings in a fusiform aneurysm, the needle should penetrate at least one quarter or one-sixth of an

FIG. 411.

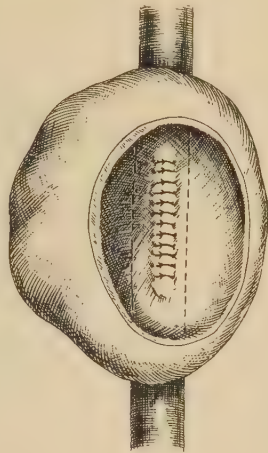


To show the closure of the orifice of communication in a sacciform aneurysm with an interrupted, instead of a continuous, suture. Whether the continued or interrupted suture be used (the former being preferred by Dr. Matas), it is important that the suture-line be some distance from the orifice, so as to enfold a considerable surface of the sac; then care must be exercised to insert the sutures so as to grasp a considerable surface of the margin, in a manner that the point of the needle shall penetrate the entire thickness of the margin, and yet not so far within the lumen of the artery as to encroach upon its calibre, or to leave the suture material in contact with the blood current. When the sutures are tightened they should bring the marginal surfaces into broad apposition without projecting into the anterior portion of the artery, or encroaching excessively upon the lumen of the vessel. (Matas.)

inch beyond the margin of the orifice, and then, after reappearing at the margin, dip again into the floor of the artery, and continue to the opposite margin, as in the start (Fig. 408). This method secures a complete apposition of a large marginal area, including the floor of the artery visible under the orifice. When the openings must be closed quickly, as in cases of considerable collateral bleeding, the dip of the needle into the floor of the vessel may be omitted, and the margins of the orifices brought together quickly with a continuous suture. When the intervening space is not too great, Dr. Matas prefers to extend the line of suture from one orifice to the other (Fig. 408). If the floor is rigid or bound down by adhesions, the sutures should be limited to the orifices.

B. *Sacciform aneurysm with a single orifice, sutures here hæmostatic and reconstructive with the view of preserving the lumen of the artery* (Figs. 410, 411, 412, and 418).—The same material and needles are used. The chief point to bear in mind is that the sutures should be inserted at a sufficient distance from the margins of the opening to secure a firm and deep hold (Figs. 410, 411, and 418). The needle should be made to appear just within the lower edge of the margin, care being taken that when the sutures are tightened, the calibre of the artery will not be encroached upon too much, and that the threads will not be in contact with the blood in the lumen of the artery. Greater care must be exercised in securing accurate coaptation in this class than in the fusiform type. As shown in Figs. 410 and 411, it will be advantageous to begin the line of suture at some distance from the orifice, as this will secure a broader and stronger line of approximation.

FIG. 412.



5. *Removal of constrictor and test of sutures.*—The interior of the cavity should now, if all visible orifices in the sac have been closed by suture, be perfectly dry. If any oozing persists, this will be stopped by pressure or by the means subsequently adopted to obliterate the sac.*

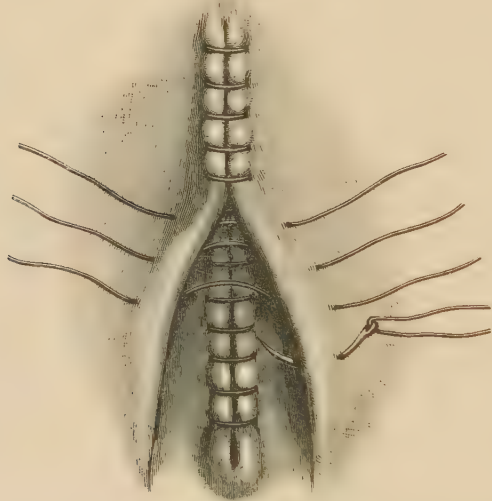
6. *Obliteration of the sac.*—This step is the same in all cases (Figs. 413, 414, and 415). In large sacs, where there is an abundance of material, it will be well to reinforce the first line of occlusive sutures by a second row, applied also on the Lembert plan at a higher level. This second row will raise up and bring together a considerable surface of the floor and lateral walls of the sac, and will not only bury the first row of sutures, but will reduce the dimensions of the sac considerably (Fig. 413). The closure of the sac is now readily accomplished by turning the relaxed flaps of skin into the cavity. If the sac has not been previously dissected from its surroundings, the skin flaps will be lined by smooth sac walls, and can, as a rule, be made to touch the bottom of the cavity with comparative ease. One or two relaxation-sutures,

This shows the completed obliteration of the orifice of the sac in a *sacciform aneurysm*. If the suture has been properly applied, the hæmostasis will be complete, and the circulation in the main artery restored. The insertion of the second row of protective sutures (Fig. 413), and the other details of the technique of the obliteration of the sac (Figs. 414 to 416) should be carried out precisely as in dealing with aneurysms of the fusiform type. (Matas.)

* In a case of Dr. Gessner's, of New Orleans (*Ann. of Surg.*, January, 1905, p. 115), of popliteal aneurysm, in which the two openings had been sutured, removal of the constrictor was followed by the escape of arterial blood above, showing either that the closure was defective or that some collateral had escaped detection. Complete hæmostasis was effected by a Lembert's suture, taking up at least an inch of the sac wall on either side. Thus the walls of the sac were brought together directly, instead of being turned in on themselves (*vide infra*).

best applied with a large fully curved needle, will usually suffice to hold down the skin flaps in contact with the bottom and sides of the sac. Through the entire thickness of this the needle should usually penetrate. By carrying it through in this way a loop is formed, the two ends of which are carried through the skin flaps by transfixion with a straight Reverdin's needle, and tied firmly over a loose pad of gauze (Figs. 415 and 416). After the relaxation-sutures have been tied a few sutures should complete the approximation of the edges of the skin.

FIG. 413.

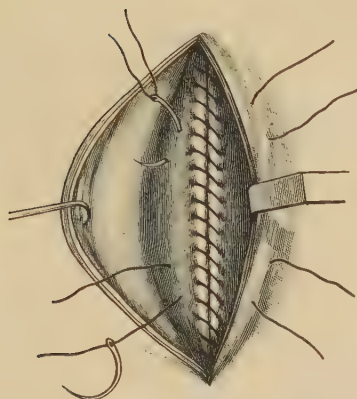


This shows the second row of sutures, a technical detail which is advantageous, but not necessary in every case. The first row has been completed, and the arterial orifices have been obliterated. As the walls of the sac are usually relaxed, it is easy to insert a second row of sutures, which add security to the first, and, in addition, reduce the size of the cavity to be obliterated by inversion of the skin and surplus sac walls at a later stage. This second row is applied, as in the case of the first, by either the continued or interrupted method, with a curved needle and Nos. 1, 2, or 3 chromic catgut. A large surface is thus brought into apposition, and the best opportunity given for plastic endoarteritis. If the floor of the sac is too rigid, or too adherent to the underlying parts, this second row may be omitted, and the obliteration of the sac undertaken. (Matas.)

Instead of a bulging swelling, there will be a depression varying in depth. There is no need for drainage.

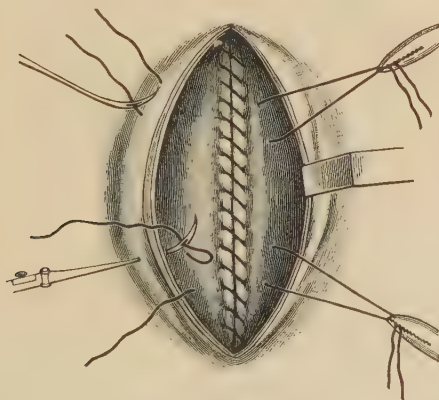
In operations upon abdominal aneurysms the peritonæum should be left adherent to the sac, and is utilised in place of the skin. In cases of deep-seated aneurysms of the extremities or neck, in stout or muscular patients, where the vitality of the skin might be imperilled by overstretching in the efforts to make it meet the bottom of the sac, Dr. Matas advises that the sac should be obliterated by its own walls. After the tying of the second or protective row of sutures (Fig. 413) the excess of the wall remaining above this row is excised, and the edges of the

FIG. 414.



To show the method of obliteration after the floor of the sac has been raised by the second row of sutures. Two deep supporting and obliterating sutures of chromic catgut are inserted through the floor of the sac on each side. The number of these will vary with the size and length of the sac. In the smaller aneurysms one of the deep sutures on each side will suffice; in others two or more may be required to keep the surfaces in close contact. After the sutures are passed through the floor of the sac the free ends of the threads are carried through the entire thickness of the flap by transfixion. The figure shows the mode of placing these sutures on the left side preparatory to transfixion of the flap. The two sutures on the right side have been carried through a flap, and are in position. (Matas.)

FIG. 415.



To show the deep supporting sutures in position and the details of transfixion of the flaps. The Reverdin needle is used to carry the free ends of the sutures through the flaps formed by the skin and walls of the aneurysm. (Matas.)

sac itself approximated with catgut sutures. The wound is then closed by rows of buried sutures.

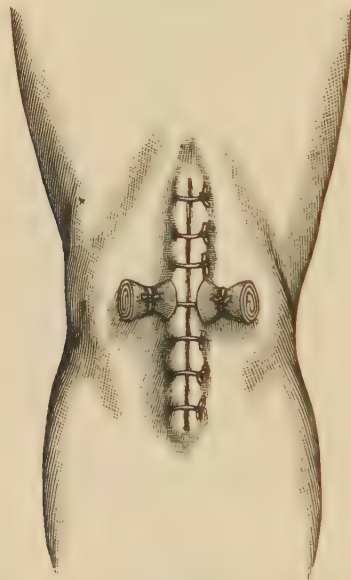
With regard to atheroma, Dr. Matas is of opinion that, with the advantages of aseptic surgery, the fear that degenerative changes will

interfere with repair of the arterial tunics has been proved to be greatly exaggerated.

Dr. Matas's third and fourth cases, in which the aneurysms were the result of disease, prove that the orifices into such aneurysms can be successfully sutured. How far the rigidity of such diseased walls may sometimes interfere with the later steps of his operation, and necessitate partial plugging with gauze, time will show.

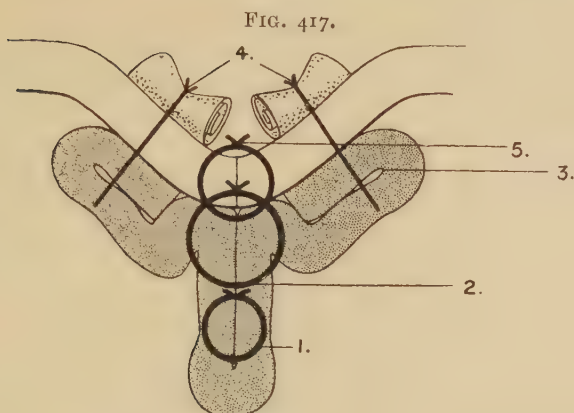
Dr. Matas contrasts the dangers of the method of Antyllus and that

FIG. 416.

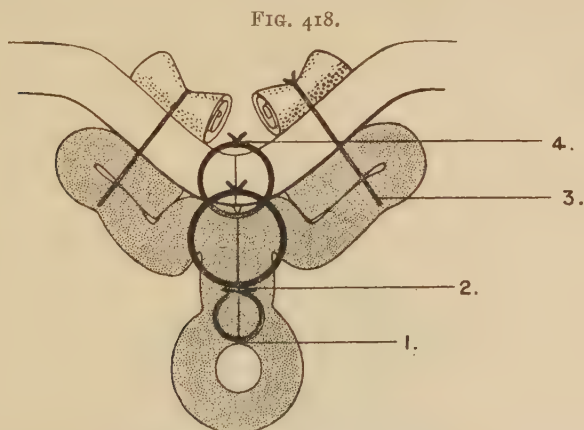


To show the operation completed. In this figure only two supporting sutures are shown on each side instead of the four shown in some of the others. The skin and walls of the sac form two lateral flaps on each side of the incision, and readily fall to the bottom of the sac, thus lining and obliterating the entire cavity. A series of absorbable interrupted sutures bring the edges of the skin into contact, several of these including the floor of the sac in their bite (as shown in cross-section, Fig. 417), so as to close the space entirely in the middle line. The two lateral supporting sutures are tied firmly over small rolls of sterile gauze, thus bringing all the interior of the sac into apposition. (Matas.)

of extirpation of the sac with the safety of his own technique. In the method of Antyllus, preliminary ligature of the main artery above and below the sac will not always control the bleeding from the collaterals, which often open into the aneurysm or into the main trunks between the orifices in the sac and the seats of ligature. In order to secure all the collaterals, a more or less extensive dissection of the sac would be usually rendered necessary unless the uncertain process of plugging the openings and the sac is resorted to. By the above dissection the difficulties of the operation are much increased, and the vitality of the limb endangered, by the interference with the collateral circulation, which, in many cases, is most freely developed in the neighbourhood



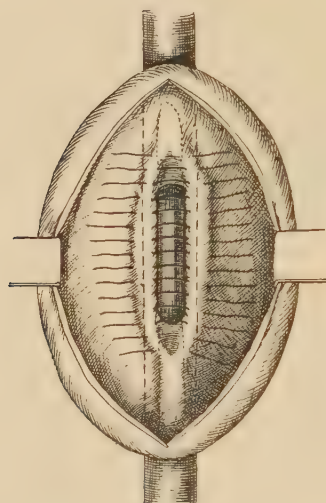
A sectional diagram showing the method of obliterating the aneurysmal sac in the *fusiform* type with two openings. In this class of cases (Fig. 407) the tunics of the artery blend with the sac, and the arterial channel cannot be restored. The diagram shows the first row of sutures (1) which obliterate the orifice of the artery at the bottom of the sac. The second row (2) is shown higher up, and also the effect of this row in reducing the capacity of the sac. The obliteration of the remaining part of the cavity by the folding in of the sac walls, with the attached overlying skin, is shown in (3). The function of the deep sutures (4) tied over gauze rolls and of the more superficial skin sutures (5) in obtaining firm contact of the opposed surfaces is also shown. (Matas.)



A diagram showing a sectional view of the obliterated sac in the *sacciform* type of aneurysm when the lumen of the artery is preserved, and the vessel originally communicates with the aneurysm by a single orifice. 1, First row of sutures, which close the orifice of communication, and restore the lumen of the parent vessel. 2, Second row of protecting sutures, which also reduce the size of the sac. 3, Supporting through-and-through sutures, which bring the roof and floor of the aneurysm into contact. 4, Sutures which hold the skin flap in contact with the bottom of the cavity. This diagram will also show the result of the procedure illustrated in Figs. 411 and 412.

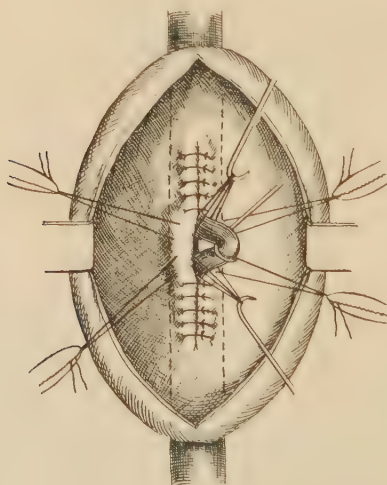
of the sac. Another serious objection is that the sac, packed or drained, has to heal by granulation, thus inviting infection and secondary hæmorrhage.

FIG. 419.



This shows a method, suggested by Dr. Matas as possible, but not yet tried, of restoring the large lumen of the artery in cases of *fusiform* aneurysm, with two openings, where the healthy and flexible character of the sac will permit of the restoration of the arterial channel by lifting up two lateral folds of the sac and bringing them together by suture over a soft rubber catheter. The principle of this operation is precisely like that of a Witzel's gastrostomy. The soft catheter is seen lying on the floor of the sac, and inserted in the two orifices of communication. The sutures are placed while the catheter is in position, acting as a guide.

FIG. 420.



This shows a more advanced stage of the procedure in Fig. 420. The sutures are nearly all tied, and the new channel is completed except in the centre. The two middle sutures are hooked out of the way while still in position, and the catheter is withdrawn. The obliteration of the sac and the final steps of the operation are carried out as in Figs. 413, 416.

Extirpation of the sac is accompanied by uncertainties and dangers even greater than those met with in the method of Antyllus, owing to the greater risk of injury to the veins and nerves, and the interference with the collateral circulation, and the risk of gangrene is here greater still.

Four cases illustrate Dr. Matas's paper, two of traumatic aneurysm of the brachial; one of the popliteal, sacciform; and one, fusiform, of the femoral artery. All were successfully treated by his method. The oldest patient was forty-five.

CHAPTER VI.

OPERATIONS ON THE LEG.

LIGATURE OF POSTERIOR TIBIAL ARTERY.—LIGATURE OF ANTERIOR TIBIAL ARTERY.—LIGATURE OF PERONEAL ARTERY.—AMPUTATION OF LEG.—OPERATION FOR NECROSIS.—TREATMENT OF COMPOUND FRACTURE.—OPERATIONS FOR SIMPLE FRACTURE.—OPERATIONS ON VARICOSE VEINS.

LIGATURE OF THE POSTERIOR TIBIAL ARTERY.

Indications.—Very few. i. Chiefly wounds. Mr. Cripps,* in a very valuable paper, divides the sources of hæmorrhage from the upper two-thirds of the posterior tibial into (1) hæmorrhage after amputation; (2) hæmorrhage from injury to the vessels in continuity. (1) Hæmorrhage after amputation.—This is usually due to a diseased condition of the vessels, and to the fact that the vessels lying between the bones are now especially difficult to take up. If from their constantly breaking away it is found impossible to deal with them, the limb should at once be amputated above the knee. If the hæmorrhage occurs later on, well-adjusted pressure (p. 926) should be carefully tried, aided or followed by ligature of the femoral or by amputation higher up. (2) Hæmorrhage from wounds of the tibials in continuity.—Three chief causes may lead to this: (a) An incised wound. (b) A punctured wound. (c) Wounds other than punctured or incised. Four methods of treatment are open to the surgeon—viz., (a) Pressure and bandaging. (b) Ligature of both ends of the vessel. (c) Ligature of the femoral. (d) Amputation. (a) *Incised Wound.*—If this is seen soon after its infliction, the bleeding point should be sought for and tied, the wound being enlarged if needful. If sloughing and extravasation of blood have taken place, amputation will probably be the wiser course, though, if the patient decide to run the risk, an attempt may be made to save his limb by making free incisions, providing drainage, plugging the wound (rendered, as far as may be, aseptic with irrigation and iodoform) with aseptic gauze, bandaging evenly and firmly, and tying the femoral in Hunter's canal. (b) *Punctured Wound.*—If this is deep, and the vessel injured uncertain, the question of treatment is a very serious one.† Mr. Cripps shows that, in the majority of instances, pressure deserves a fair and thorough trial. If it is useless, or prejudicial to other treatment, either the femoral must be tied, or the wound enlarged to secure the wounded vessel. Between these operations the features of the particular case must decide. If pressure is made use of, it should be applied methodically and with intelligent purpose (p. 926), and so that it needs no alteration or repetition.

* *St. Barthol. Hosp. Reports*, vol. xi. p. 94; *Dict. of Surg.*, vol. ii. p. 626.

† Where the wound has passed obliquely, Dupuytren's words should be remembered. They refer to hæmorrhage from the calf caused by a pistol-bullet. "Should a ligature be placed on the ends of the divided vessel? But what were those vessels? Was it the anterior or posterior tibial, or the peroneal or the popliteal? Was it several of them at the same time? Should they be attacked before or behind?"

(c) *Wounds other than Punctured or Incised—viz., Injury to the Vessel from Fracture or Gunshot Wound.*—In many cases conditions will be present which will call for amputation—viz., the severity of the crush ; the extent of the comminution ; injury to the nerves or to both arteries, as evidenced by the condition of the foot ; and the age or the vitality of

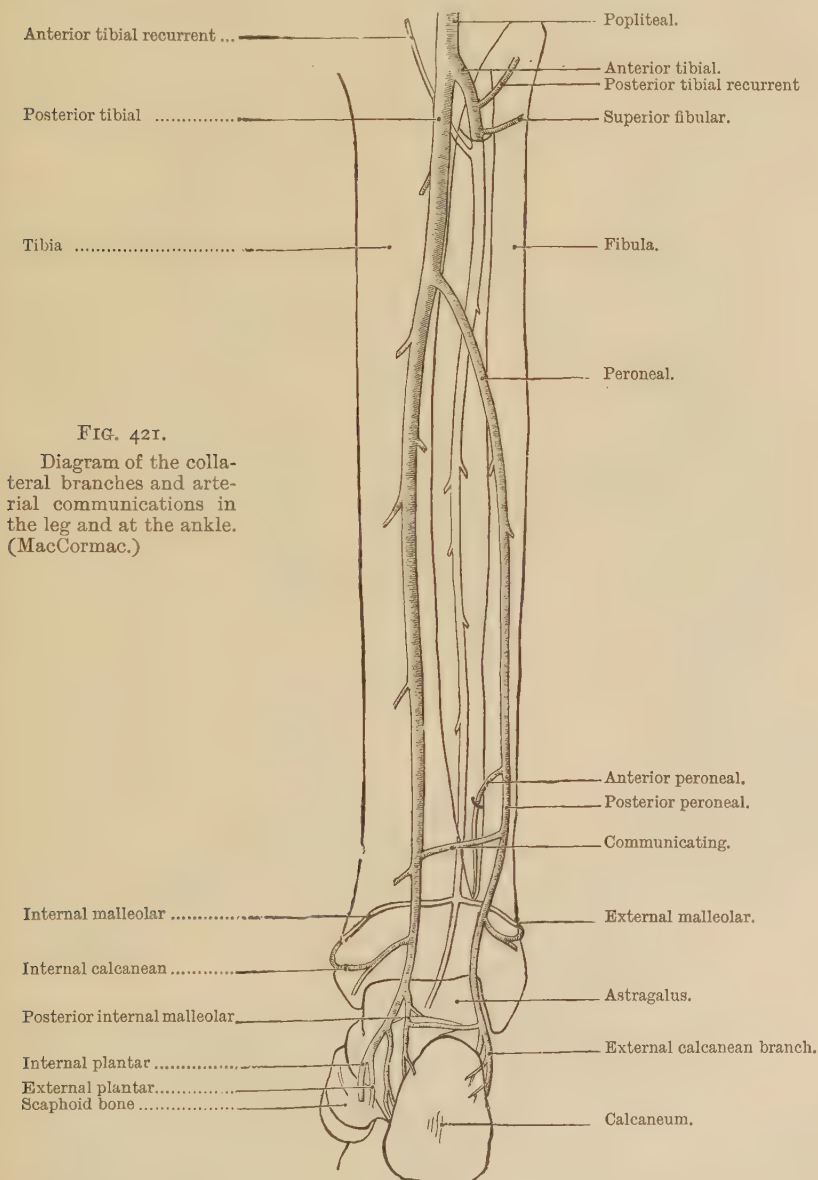


FIG. 421.

Diagram of the collateral branches and arterial communications in the leg and at the ankle. (MacCormac.)

the patient. In most of these cases, as an attempt to find the vessel involves great difficulty and danger, and the probabilities of success diminish as the interval between the infliction and treatment of the injury increases, ligature of the femoral would be less hazardous than any interference with the wound. But amputation will frequently be needed. The above remarks apply to compound fractures ; an instance of successful ligature

of a lacerated femoral co-existing with a compound fracture of the leg is given at p. 921.
 ii. Small traumatic aneurysms. iii. The posterior tibial may be tied low down, together with the dorsalis pedis, for certain wounds of the sole or for some vascular growths of the foot.

LINE AND GUIDE.—A line drawn from a point at the lower part of the centre of the popliteal space to one midway between the tendo Achillis and the internal malleolus.

RELATIONS.—These differ according as the vessel is tied—(A) in the middle of the leg, (B) in the lower third of the leg, (C) at the inner ankle.

A. Relations in the Middle of the Leg :

SUPERFICIAL.

Skin ; fasciæ ; branches of saphenous veins and nerves.
 Gastrocnemius ; soleus ; plantaris.
 Special fascia ; transverse branches of venæ comites ;
 tendinous origin—arch—of soleus (above).

OUTSIDE.

Vena comes.
 Posterior tibial nerve
 which has crossed
 above from the
 inner side.

Posterior tibial.

INSIDE.

Vena comes.
 Posterior tibial nerve
 (above).

BENEATH.

Flexor longus digitorum.
 Tibialis posticus.

B. Relations in Lower Third of Leg :

SUPERFICIAL.

Skin ; fasciæ ; superficial veins and nerves.

OUTSIDE.

Vena comes.
 Posterior tibial nerve.
 Tendo Achillis.

Posterior tibial.

INSIDE.

Vena comes.

BENEATH.

Flexor longus digitorum.
 Tibia.

C. Relations at Inner Ankle :

SUPERFICIAL.

Skin ; fasciæ ; branches of internal saphena vein
 and nerve.
 Internal annular ligament.

OUTSIDE.

Vena comes.
 Flexor longus hallucis.
 Posterior tibial nerve.

Posterior tibial.

INSIDE.

Vena comes.
 Flexor longus digi-
 torum ; tibialis
 posticus.

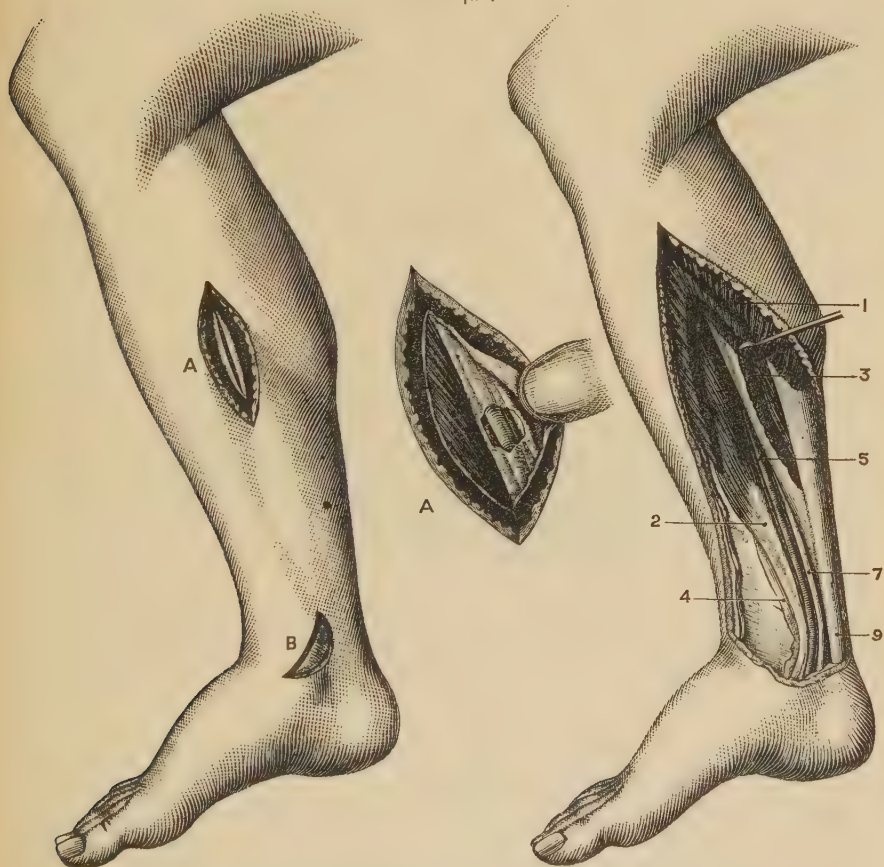
BENEATH.

Internal lateral ligament.

Operation in Middle of Leg (Figs. 422 and 423).

The parts having been sterilised, the knee flexed, and the limb supported on its outer side, the surgeon, standing or sitting on the inner side, makes an incision three and a half inches long, parallel with the centre of the inner border of the tibia, and half or three-quarters of an inch behind it, according to the size of the limb. This incision divides

FIG. 422.



Ligature of the posterior tibial artery. (Heath.)

A, Incision for ligature of the artery in the leg.

B, Incision for ligature of the artery at the inner ankle.

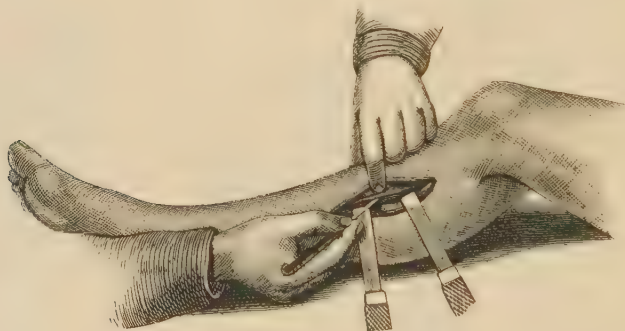
1, Gastrocnemius. 2, Flexor longus digitorum. 3, Soleus. 4, Tibialis posticus.

5, Posterior tibial artery. 7, Posterior tibial nerve. 9, Tendo Achillis.

skin and fasciæ. If the internal saphenous vein is met with, it must be drawn aside with a strabismus-hook; any of its branches may be divided between two ligatures. The deep fascia is then freely slit up, and the inner edge of the gastrocnemius defined and drawn backwards. This will expose the soleus, the tibial attachment of which is to be cut through, any sural artery being at once secured. The incision through the soleus (Fig. 422) should be three inches long and quite half an inch

from the tibia; as the fibres are divided, the central membranous tendon will come into view, and must not be confused with the special deep fascia or intermuscular septum over the deep flexors. Usually, before this comes into view, some additional fibres have to be divided. When this is done, the above special fascia must be identified, stretching between the bones. The wound must be carefully dried, well opened out with retractors, and exposed with a good light at this stage. The deep fascia being opened carefully, the nerve usually comes into view first, the artery lying a little deeper and more external. The venæ comites should be separated as far as possible, but rather than puncture them and cause hæmorrhage at this stage, or waste time, the surgeon should tie them in. The needle should be passed from the nerve. To facilitate this, the knee should be well flexed, and the foot also flexed downwards so as to relax the muscles thoroughly. The ligature will lie below the peroneal artery.

FIG. 423.



Ligature of the posterior tibial at the middle of the calf. The inner head of the gastrocnemius is drawn backwards by retractors. The left index raises the anterior lip of the wound while the soleus is divided perpendicularly to its surface. (Farabeuf.)

Operation in Lower Third of Leg.—The limb and the operator being in the same position as before, an incision two and a half inches long is made through skin and fasciæ, parallel with the inner border of the tibia, and midway between it and the tendo Achillis; after the deep fascia has been opened another layer, tying down the deep flexor tendons, will require division. The artery here lies between the flexor longus digitorum and pollicis, surrounded by venæ comites. The needle should be passed from the nerve, which lies to the outer side. If the incision is made too high, some of the lowest fibres of the soleus will require detaching from the tibia; if too low, the internal annular ligament would be opened. The sheaths of the flexors (their synovial investment commences about an inch and a half above the internal malleolus) should not be interfered with.

Operation at the Inner Ankle (Fig. 422).—The limb and operator being placed as before, a curved incision, two inches long, is made, three-quarters of an inch behind the internal malleolus. Skin and fasciæ being divided, any branches of the internal saphena vein tied,

the internal annular ligament is divided, and the artery found closely surrounded by its veins. The nerve lies externally, and the needle should be passed from it. The artery is so superficial here that the veins can be easily separated. The nerve has occasionally bifurcated higher up.

LIGATURE OF THE ANTERIOR TIBIAL.

Indications.—These are very few, and resemble so closely those already given for the posterior tibial—viz., wounds and traumatic aneurysm—that there is no need to go into them again here.

In the course of 1887, I had occasion to tie the anterior tibial in its lower third for profuse hæmorrhage from a compound fracture, not arrested by pressure.

There was a compound comminuted fracture of the right leg, in the lower third, from a fall of 4 cwt. upon the limb. The upper end of the artery was found with some difficulty, owing to the pulped condition of the soft parts. Having failed to find the lower end, I was about to expose the *dorsalis pedis*, and trusting to antiseptic precautions, trace this up to the anterior tibial, when, an urgent strangulated hernia being admitted, I plugged the wound, all the undermined parts being previously laid freely open. No recurrence of bleeding took place, and the man (aged 44) made an excellent recovery, aided by his temperate life and patience, and the freedom with which the wound was laid open.

Dr. Shepherd, of Montreal (*Ann. of Surg.*, No. 1, p. 7), gives another, but more difficult, case in which the compound fracture was about the junction of the middle with the upper third of the leg.

The bleeding was first arrested by pressure. On the fourth day a traumatic aneurysm appeared. The artery was exposed with difficulty,* and found partly divided; two ligatures were applied, and the patient made a good recovery.

LINE AND GUIDE.—From a point midway between the head of the fibula and the outer tuberosity of the tibia to the centre of the front of the ankle-joint; the outer edge of the *tibialis anticus*.

RELATIONS :

SUPERFICIAL.

Skin; fasciæ; cutaneous branches of saphenous veins and nerves, and (below) musculo-cutaneous nerve.

Tibialis anticus and *extensor longus digitorum* (above), overlapping.

Tibialis anticus and *extensor longus hallucis* (below), overlapping.

* Dr. Shepherd points out that, the injury to the vessel being just in front of the place where it pierces the interosseous membrane, if the artery had been completely torn through it would have retracted through the opening, and ligature would have been impossible. Mr. F. Page (*Lancet*, 1887, vol. i. p. 522) gives a case of traumatic aneurysm of ten weeks' duration, after a stab, at the junction of the middle and lower thirds of the leg. The swelling had been poulticed and opened, with the result of hæmorrhage. Mr. Page, on clearing out the clots and opening up the swelling, was unable to find the anterior tibial artery. Hæmorrhage recurring, the leg was amputated. The patient recovered.

OUTSIDE.	Anterior tibial artery.	INSIDE.
Extensor longus digitorum (above).		Tibialis anticus.
Extensor longus hallucis (below).		Vein.
Anterior tibial nerve.		
Vein.		

BENEATH.

Interosseous membrane.

Operation at the Junction of the Upper and Middle Thirds of Leg (Figs. 424, 425).—The knee being flexed and the limb supported upon its inner side, the surgeon having defined, if possible, the outer edge of the tibialis anticus,* sits or stands on the outer side of the patient, and makes an incision about four inches long in the line of the artery, beginning about two inches below the head of the tibia. This incision should lie (if the edge of the muscle has not been marked out)

FIG. 424.



Ligature of the anterior tibial artery at the junction of the middle and upper thirds; division of the deep fascia on a director (p. 1000). The leg is generally flexed. (Farabeuf.)

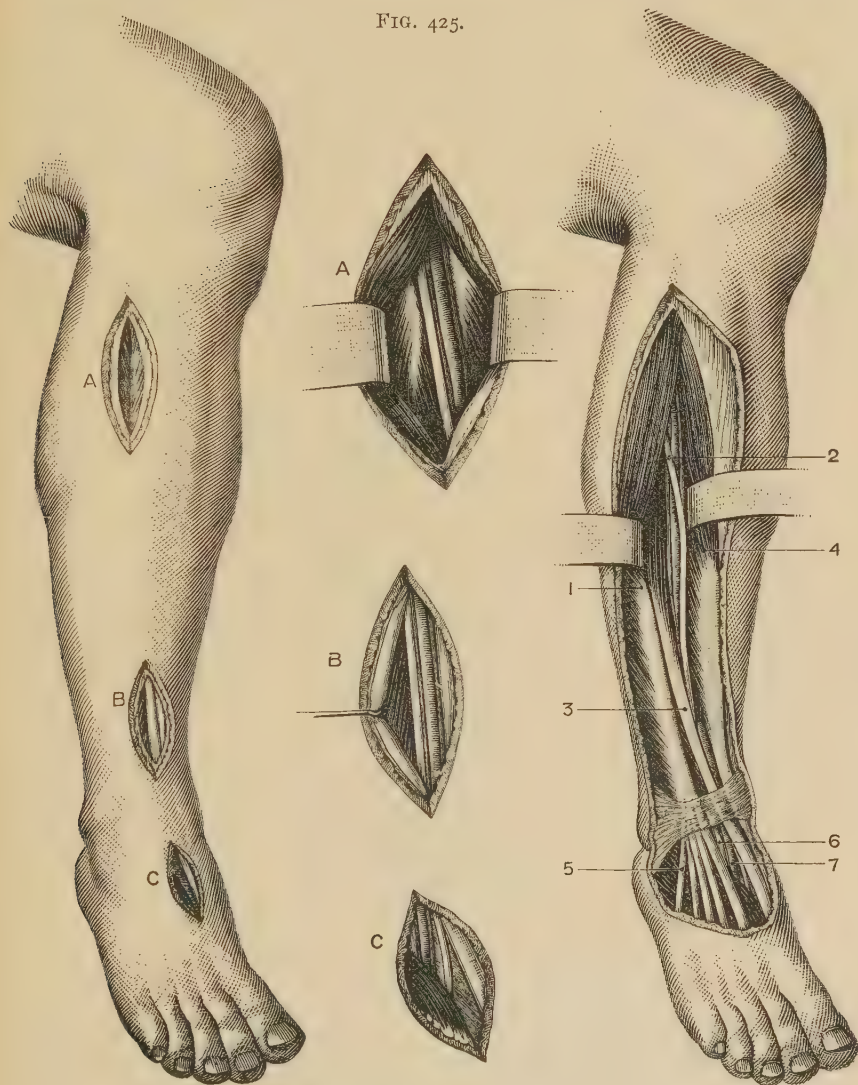
three-quarters to one inch—according to the size of the leg—from the crest of the tibia, and should expose the deep fascia carefully, so that the white line which marks the desired intermuscular septum may be looked for. This line is often whitish-yellow, and varies much in distinctness. If there is any difficulty in finding it, any bleeding points must be secured, and the deep fascia slit up over the line of the artery, and the finger-tip inserted to feel for the sulcus between the muscles. A third aid is almost constant, and that is a small muscular artery† which comes up between the tibialis and the extensor longus digitorum. The sulcus being found between the muscles (without tearing them), they are separated with the handle of a scalpel or a steel director, and retractors inserted, the outer one being hooked over the fibula. If the limb is a very muscular one, the deep fascia should be nicked transversely at the upper and lower extremities of the wound, and the parts more relaxed by bending the knee more and pressing the foot upwards.

* The patient may put this into action just before the anæsthetic is taken.

† This was pointed out by Mr. C. Heath (*Oper. Surg.*, p. 47). I have found the same fact most helpful in the ligature of the ulnar in the middle third of the forearm.

The finger, now directed towards the interosseous space, feels for the artery deep down in the bottom of the wound. The nerve should be

FIG. 425.



Ligature of the anterior tibial artery. (Heath.)

A and B, Incisions for ligature of the anterior tibial artery.

C, Incisions for ligature of the dorsalis pedis artery.

1, Extensor longus digitorum. 2, Anterior tibial vessels and nerve. 3, Extensor proprius hallucis. 4, Tibial anticus. 5, Peroneus tertius. 6, Anterior tibial nerve. 7, Dorsalis pedis artery.

drawn to the outer side. If much trouble is met with in separating the venæ comites, they may be included.

In a case which still presents difficulties the following directions of

M. Farabeuf may be useful (*Man. Oper.*, p. 89): The two lips of the wound having been separated, the deep fascia is opened close to the inner lip and the grooved director introduced beneath it,* and pushed across gently until its tip is arrested by the first intermuscular interval and septum, that between the tibialis anticus and the extensor digitorum. If the operator pushes it too far it will be arrested by the better-marked septum between the peronæi and extensors. In cutting upon it the operator will have crossed the desired interval.

Operation at the Junction of the Lower and Middle Thirds of Leg (Fig. 425, B).—An incision about two inches and a half long is made in the line of the artery; in the upper part, this incision will be about one inch from the tibia. The white line and the interval between the tibialis anticus and the extensor proprius hallucis are both looked and felt for. The deep fascia being divided and the muscles relaxed and retracted, the artery is found surrounded by its venæ comites. The needle must be passed from without inwards.

LIGATURE OF THE PERONEAL ARTERY.

Indications.—As these are extremely few, and as in the case of a wound of the vessel (which is very rarely met with) the best course would be to enlarge the wound, any formal operation for its ligation need only be very briefly described.

RELATIONS.—The peroneal artery comes off from the posterior tibial about one inch below the popliteus, descends at first parallel with this artery but separated from it by the posterior tibial nerve; it then passes outwards towards the fibula, and runs down between this bone and the flexor longus hallucis. In the upper part of its course it lies upon the tibialis posticus, and is covered by the soleus.

Operation.—To tie the artery when no wound is present to guide the surgeon, an incision three inches long should be made along the posterior border of the fibula, with its centre at the junction of the upper and middle thirds of the leg. The gastrocnemius being drawn aside, and the soleus separated from its attachment to the fibula, the special deep fascia is slit up and the artery sought for close to the fibula.

AMPUTATION OF THE LEG.

Different Methods (Figs. 426—432).

1. **Lateral Flaps** (Figs. 426—429).
2. **Teale's Rectangular Flaps** (Figs. 430—432).
3. **Antero-posterior Flaps of Skin.**
4. **Antero-posterior Flaps, Anterior of Skin, Posterior by Transfixion of Muscle.**
5. **Circular.**

I shall only describe the first two, as they will be found adapted to all emergencies, and to be devoid of the disadvantages of the others.

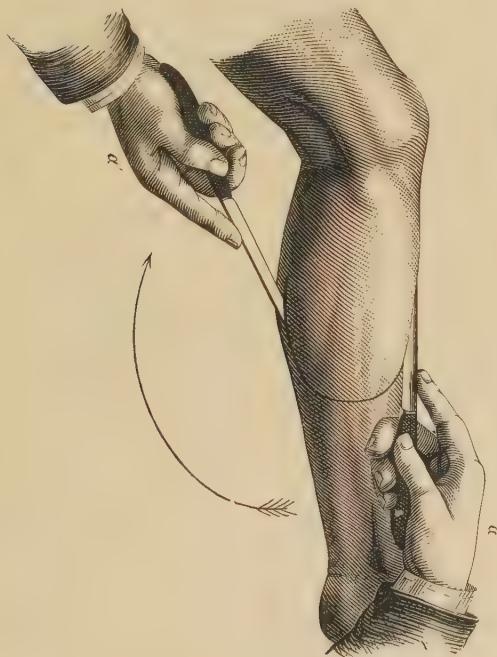
1. Lateral Skin Flaps, with Circular Division of the Muscles, &c.—This is, I believe, a method not well known beyond Guy's Hospital and those who have been taught there. It will not only be found most convenient at the time, but it also gives very satisfactory results afterwards.

* Though in Fig. 424 M. Farabeuf figures the director introduced from without, he directs that it be passed as described above and figures it so in another illustration.

The blood-supply is well and equally distributed to the lateral flaps, one can be conveniently cut longer than the other, and they are more easily shaped and dissected up than antero-posterior skin-flaps, while no mass of muscle is left to drag away from and expose the bones, as in the antero-posterior flaps, with the anterior of skin and the posterior by transfixion.

Operation (Figs. 426—429).—The femoral artery having been commanded, the leg brought over the table, and the damaged or diseased parts bandaged in sterilised towels—so as to give the assistant a firm

FIG. 426.



Amputation of the leg by lateral flaps.
(Farabeuf.)

FIG. 427.



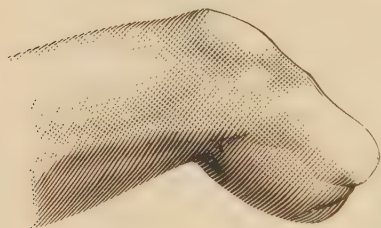
Amputation of the leg by lateral flaps. The muscles are being severed with circular sweeps of the knife.

hold and also to prevent his soiling the flaps later on—the opposite ankle is tied to the table. The surgeon, standing to the right of the limb, places his left index on the crest about an inch below the tubercle, and his thumb at a corresponding point behind in the centre of the limb. Looking over, he inserts his knife close to the thumb, and cuts on the side of the limb farthest from him a lateral flap broadly oval in shape and three inches long, ending at the index finger, from which point, without removing the knife, a similar flap is marked out ending on the back where the first began.* Flaps of skin and fascia are now

* If the condition of the soft parts demand it, not only can one lateral flap be shaped longer than its fellow, but antero-external and postero-internal flaps can be employed.

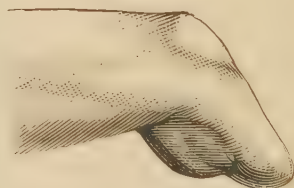
dissected up, and the muscles all cut through with a circular sweep of the knife at the intended point of bone-section, this sweep being repeated two or three times till the soft parts are all cleanly severed. The posterior muscles should be cut a little longer than those in front, owing to their greater retraction (Figs. 428, 429). The interosseous membrane is next divided, so that it shall not be frayed by the saw, and with one final, firmly drawn, circular sweep the periosteum is grooved for the saw.* This is then applied with the following *precautions*. The position of the fibula behind the tibia and its much smaller size must be remembered, lest it be splintered. This may be avoided by rolling the leg well over on to the inner side, and placing the saw well down on the outer side so as to start the section of the bones simultaneously, and thus ensure complete division of the fibula before the tibia. This object may also be effected, if the leg is held in the ordinary position, by applying the saw to the tibia, and remembering, when this bone has been sawn half through, to depress the handle, and thus complete the section of the bones simultaneously. In

FIG. 428.



Amputation of the leg at the seat of election by lateral flaps, a good stump resulting. (Farabeuf.)

FIG. 429.



Amputation of the leg by lateral flaps at the seat of election. The posterior muscles, cut too high, have retracted greatly, and an ugly conical stump is the result. (Farabeuf.)

either case the saw should be used lightly and quickly, with the whole length of the blade, and without jamming. As the sharp projecting angle of the crest tends to come through the anterior angle of the flaps, this may be sawn off obliquely after the bones are sawn.

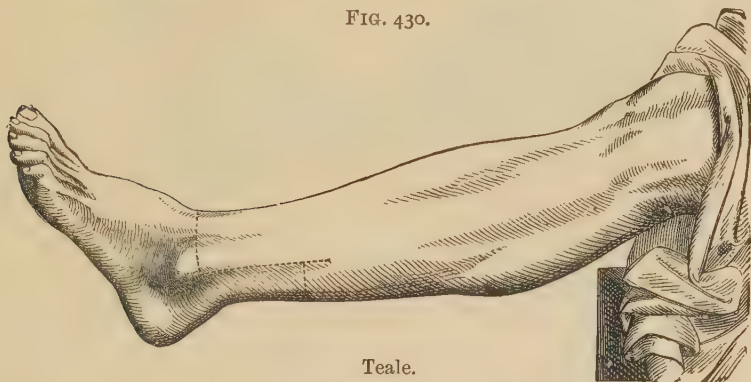
Bier's Osteoplastic Method of Amputation.—The following advantages are claimed for this procedure by the inventor (*Centr. f. Chir.*, 1897, Hft. 31, S. 834), J. H. Pringle, of Glasgow (*Lancet*, November 18, 1905), and Moscowitz, of New York (*Med. News*, February, 1901):—(1) The patient can bear his whole weight on the stump, whether this has been made through the bones of the leg or the femur, as well as a patient can do so after a Syme's amputation. (2) He can wear an artificial limb earlier. Thus Mr. Pringle writes: "At the end of four weeks, as a rule, I fix a wooden pin-leg to the stump by plaster of Paris bandages, and get the patient up." The disadvantages are: (1) that the raising the bony part of the flap is not easy: a suitable saw,

* Nowadays, with modern precautions, the old need of periosteal flaps—viz., to keep pus, &c., out of the diaphysis and medullary canal—is no longer present. Furthermore, these flaps are very difficult to raise, unless inflamed, especially in the thin periosteum of adults.

e.g., a small one of the keyhole pattern or a Gigli's saw set in a frame, must be at hand. (2) This flap may necrose and cause trouble. (3) Longer time is obviously required.

Operation.—To take the case of the leg, flaps are marked out as before, a large antero-internal or antero-external being preferred by Bier. Whatever flaps are employed, great care must be taken not to injure the periosteum on the inner side of the tibia. The next step is the raising of the osteoplastic flap. A rectangular flap of periosteum is marked out on the inner side of the tibia. This must be large enough to cover easily the sawn surfaces of the tibia and fibula, and care must be taken to cut the periosteum longer than the bone, both at the sides and margin of the flap, so that it can be sutured in place later without any tension on the pedicle of periosteum which remains attached to the tibia. The cut edges of periosteum having been sufficiently raised, a thin bony flap is then cut out from the inner surface

FIG. 430.



Teale.

of the tibia partly with one of the saws mentioned above, partly with a chisel. Its base must be either snapped through or divided with a saw or chisel. Its pedicle must be carefully preserved intact. The soft parts are next divided, the bones sawn and the vessels secured at the base of the flap or flaps, great care being taken not to injure the flap of bone and periosteum. This is now carried across the sawn surfaces of tibia and fibula and kept in place by sutures of sterilised silk which take up the cut fasciæ, tendons and periosteum of tibia and fibula. If the flap be not large enough to cover the cut surface of the fibula, this bone should be divided again at a slightly higher level. Actual bony union does not appear to be absolutely essential for a perfect functional result.

Teale's Amputation by Rectangular Flaps (Figs. 430—432).—This method is rarely employed. In hospital practice, where amputation of the leg is usually called for, amputation at "the seat of election," so that the patient can bear his weight on parts used to pressure, is always preferable, and lateral flaps give here the best results, at the least expense of tissue, and in the shortest time. In the better ranks of life, where the patient can afford and use comfortably a well-moulded leather socket,* a longer stump may be

* Hospital patients occasionally ask for and get together the money, on the first occasion, for one of these expensive legs. The well-moulded socket on which the bearing of the weight comfortably depends is quite unfitted for the hard wear and tear, perspirations, &c., to which it will be submitted.

made, here also by lateral flaps, as the pressure will now not be taken on the face of the stump, but distributed over the socket.

Advantages.—1. The covering for the bones is ample, and the flaps come together without tension.* 2. The way in which the flaps are united favours drainage during healing, and provides a scar well out of the way of pressure. 3. The stump bears pressure well.

Disadvantages.—1. It is an expensive method, involving a high section of the bones. 2. The long anterior flap may slough. 3. If performed with the accuracy of its introducer, it involves more time than that by lateral flaps (*vide supra*), and is, thus, not suited to cases of shock.

Operation.—The preparatory steps, and the position of the operator and patient, are

FIG. 431.



FIG. 432.



Teale.

as at p. 1001. The surgeon having measured the circumference of the limb at the spot where he intends to saw the bones, and placing here his left index and thumb on the tibia and fibula, traces out a long rectangular, anterior flap which is to be, both in its length and breadth, equal to half the above circumference.† In tracing this flap the incision starts from the index finger, runs down along the bone farthest from the surgeon for four inches and a half (if the circumference at the site of bone-section is nine inches), then

* Save when infiltrated. The difficulty of getting the anterior flap into position is then often considerable.

† In the lower third, where the leg tapers quickly, care must be taken to keep this flap of the same width below as it is above.

crosses the limb, cutting all the structures down to the bones—this end of the flap being also four inches and a half wide—and then travels up along the opposite bone to the surgeon's thumb. The anterior flap is then dissected up partly with the knife—*e.g.*, on the inner side, where the scanty coverings must be raised as thick as possible and without scoring, partly with the knife and partly with the finger on the outer aspect, where the extensors, anterior tibial vessels, and nerve must be stripped up, uninjured, from the interosseous membrane (Fig. 431). The posterior flap, which has been previously marked out fully one-third in length of the anterior, is now made by the surgeon looking over the limb and passing his knife beneath it, and cutting everything down to the bones. It is next raised as high as the point where the bones are to be sawn. The interosseous membrane and the bones are then attended to, with the precautions given at p. 1002.

The vessels being secured and drainage provided, the anterior flap is folded over the bones (care being taken not to double it too sharply), its cut end stitched to the cut end of the posterior flap, and the portion folded below the bones stitched to that folded above them (Fig. 432).

SEQUESTROTOMY.

As the removal of necrosed bone is most frequently required in the leg, the above operation will be described here.

Indications.—The question will often arise as to whether the case is ripe for operation. The chief points bearing upon this and the looseness of the sequestrum are—(1) The time that has elapsed since the beginning of the illness; thus, two to three months will probably be required in the case of the tibia, but more likely six in that of the femur. (2) The age and general health* of the patient. The younger the patient, and the more vigorous his vitality, the more rapidly will the sequestrum become detached. (3) The size of the sequestrum. The larger and more tubular the sequestrum, the slower will be the process. (4) The feel of the sequestrum. When steel probes announce this to be dry, hard, and ringing, exploration is justified, especially if the sequestrum can be felt to be loose or depressed by the probe. (5) The size and amount of the new shell of bone. The more distinct this is, the more probable is it that the process of separation is complete.

Operation.†—This should be always conducted with strict antiseptic precaution throughout, for these reasons—(a) to prevent any risk of setting up infective osteo-myelitis; (b) to diminish the amount of sup-puration, and so the risk of necrosis after the interference with the periosteum which is entailed by the operation.

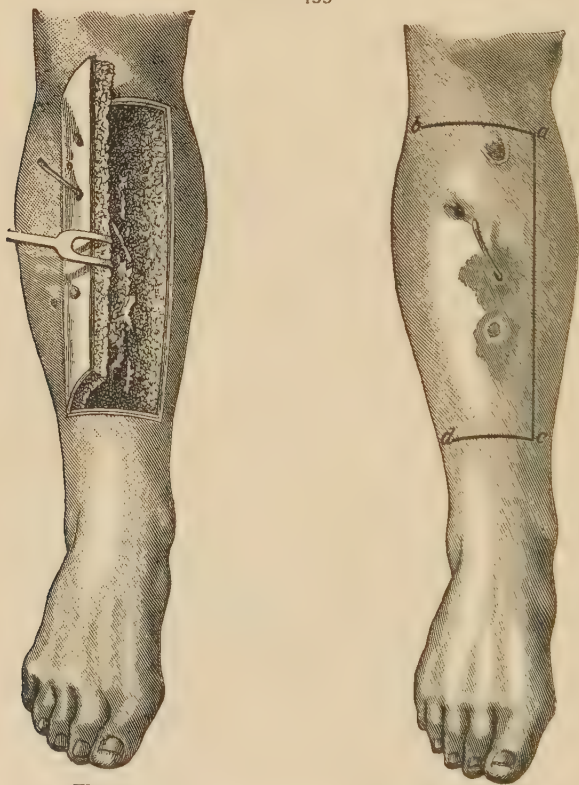
The limb, having been rendered evascular by vertical elevation while the patient is taking the anæsthetic, and the application of Esmarch's bandages, is firmly supported on sand bags, steel probes are placed in the cloacæ which mark the limit of the disease, and with a strong-backed scalpel the surgeon makes an incision between them on the inner surface of the tibia down to the bone. If only one sinus is present, this will probably be taken as the centre of the incision. This incision should be made to surround the sinus or sinuses so that the edges of these are removed. The soft parts being reflected, with every care of the periosteum, partly with the finger, partly with a blunt dissector, the new sheath of bone, spongy and vascular, is thoroughly exposed. This is then cut into and sufficiently removed with a chisel

* Freedom from syphilis and phthisis will be noted.

† It is supposed here that the sequestrum is one of considerable size.

and mallet, to expose its cavity completely from end to end.* The sequestrum is now removed with sequestrum forceps, or prised out with an elevator. If too large, it must be divided with cutting forceps. The bed of ill-formed granulation-tissue in which the sequestrum lay is then carefully examined for any small bit which may be concealed, and this tissue, together with that lining the sinuses, is all scraped away with a sharp spoon, and the cavity left thoroughly cleansed, *e.g.*, with formalin solution (1 in 250), or pure carbolic acid. The resulting cavity is then carefully plugged with sterilised gauze dusted with

FIG. 433.



Flap method of sequestrotomy. (Tillmanns.)

iodoform, the dressings being bandaged firmly on while the limb is elevated, and not till then is the Esmarch's bandage removed. If the bandage is removed before the dressings are applied, such free venous oozing takes place that the plugs are at once loosened and rendered inefficient, and the wound has to be re-dressed shortly. The limb is

* Sir H. Howse (*Brit. Med. Journ.*, 1874, vol. i. p. 475) lays great stress on the need of this. The new bone should be removed as far as the probe can be passed upwards or downwards inside it, so as to make the whole easily granulate up from the bottom. Otherwise, the part that is not laid open will very likely persist with a sinus. Furthermore, laying the whole cavity open not only ensures its granulating up from the bottom, but also allows of the removal of all ill-formed and infective material.

kept raised on a back splint and an injection of morphia given, if needed.

In order to curtail the period of after-treatment, which is extremely prolonged and tedious owing to the slowness with which healing takes place in the large cavity left, an attempt has been made by German surgeons to raise a flap which includes the anterior portion of the involucrum, as shown in Fig. 433. The flap *b a c d* is first marked out by skin incisions passing down to the bone, and the latter then divided along the lines of incision with a sharp chisel or osteotome. This having been done, the flap is prised up sufficiently to expose the cavity in which the sequestrum lies, and the latter then removed. All the granulation tissue lining the cavity and the sinuses is now thoroughly removed with a sharp spoon, and the skin forming the margins of the sinuses excised. The cavity in the bone, the sinuses, and the surrounding skin are now thoroughly cleansed, the flap replaced and sutured, and the wound dressed. In a few cases thus treated, where the attempt at rendering the wound aseptic has been successful, rapid healing by organisation of blood-clot may take place.

As the formation of sequestra is, nowadays, very largely preventible, I shall take an opportunity here of making a few practical remarks on the disease which is largely responsible for necrosis of long bones, infective juxta-epiphyseal osteo-periostitis. i. *Anatomy of the parts first affected: its bearing on the disease.* (a) In a young patient, the juxta-epiphyseal area contains growing cellular tissues of much activity, delicate, complicated and unstable, with an equilibrium which is easily disturbed, and a resistance which is often small; (b) hosts of vessel-loops are also present, imperfect in their embryonic structure, communicating freely and unable to expand; (c) at this age the richly cellular periosteum divides at the above area into two layers, one continuous with it, the other descending to blend with the cartilage of the joint. In the above tissues some slight injury, exposure to cold or an exanthem leads to the arrest of the ordinary pyo-cocci which, if not present in the patient, abound universally wherever men congregate. Results of such arrest are violent inflammation, hæmorrhages, thrombosis, suppuration with different lines ready for this to travel along, necrosis, and many possibilities of auto-inoculation. ii. *As the diagnosis is sometimes far from easy, and as this most grave disease is liable to be mistaken for acute rheumatism, cellulitis, or an exanthem, one absolute rule should always be remembered in acute pyrexias of doubtful origin in young subjects, and that is to remember the presence of juxta-epiphyseal areas.* iii. With regard to the nature of the early interference which is always imperatively called for, there are two camps of opinion as to whether the periosteum is ever affected alone, i.e., without the medulla. In my experience it certainly is so in the early stage.

This is a question very largely affected by the surroundings. A surgeon with a well-equipped hospital at his back is very differently placed from a general practitioner in the country. The latter may feel confident that a free incision may be safely made down to the bone, in the case of the femur in either of the sites given at p. 943. The following would be indications to my mind for exploring and endeavouring to disinfect the medulla itself: (1) gravity of the general symptoms from the first; (2) obscurity of the local symptoms; (3) failure of

relief after free incision of the periosteum; (4) a soft condition of the bone when cut down upon, to the finger or director.

Two more questions connected with the above disease require to be alluded to; viz., those of **amputation** and the performance of **early sub-periosteal resection**—i.e., as soon as the bone is dead, and before any new shell has formed around it. The following are some of the conditions in which the question of **amputation** will arise: failure of the above treatment, especially if initiated late; involvement of joints, especially if drainage of both knee and ankle has failed; presence of chronic septicæmia or pyæmia and the existence of other pyæmic lesions; a patient with a vitality so low as to render him unequal to meet further calls upon it.

Early sub-periosteal resection.—This is so simple an operation in the case of the tibia, and its advantages over the expectant treatment are, at first sight, so great, that it has frequently been performed. (1) Thus it removes what may be the source of dangerous infection, and (2) it avoids the need of any operation for the removal of a sequestrum, and the tediousness of waiting and of the after-convalescence. The very serious disadvantage of shortening of the limb which has occurred in the majority of cases, though the fibula is present to act as a stay between the knee- and ankle-joints, more than outweighs the above advantages. This shortening has occurred even when the periosteum has been carefully preserved and even portions of the ends of the diaphysis left to ensure portions of the epiphysial cartilages persisting. While I am aware that successful cases have been reported, we hear nothing of the unsuccessful ones. The results are extremely uncertain owing to causes at present not definitely known. Where regeneration of bone has not taken place the limb is an extremely useless one (p. 1009). Nowadays, early diagnosis and early operation should render these cases of necrosis extremely rare. Where they occur, it is possible that the Röntgen-rays by the information they may give as to the thickness of the periosteum and the involucrum will very likely enable the sequestrum to be removed at an earlier date.

BONE-GRAFTING. FILLING UP OF BONE-CAVITIES.

The subject of **bone-grafting** to replace the results of necrosis has been referred to at some length in Vol. I., at p. 159, where Sir W. Macewen's success in building up the shaft of a humerus with pieces of bone removed during osteotomies, and at p. 455, where Mr. Watson Cheyne, C.B., restored the nose with pieces of a bone of a rabbit, are related in some detail. Two other methods have been employed in recent years.

Friedrich, of Griefswald (*Germ. Congr. of Surg.*, April, 1904), reported rapid healing and good functional results in two cases in which the diaphysis of the tibia and femur had been removed and replaced by the corresponding shaft from another human being, the bone used being first deprived of its marrow and sterilised by boiling. In a girl, æt. 8, in which the entire shaft of the femur had been removed for an endosteal sarcoma, a child's tibia was used. Healing was rapid, and the child was able to run with the help of a splint and cane. In another

child 14 ctm. of the femur were replaced by part of the femur from a woman who had died of gastric cancer.

A modification of grafting which may be termed **bone-transference** may be usefully employed in the case of two contiguous long bones.

Dr. Huntingdon, of San Francisco, drew attention to this common-sense and useful principle (*Ann. of Surg.*, Feb. 1905, p. 249), with a successful case, though his paper is lacking in details of technique, where these are most needed. Dr. Donald, of Paisley (*Brit. Med. Journ.*, May 12, 1906) successfully employed the same principle in a boy of five. As in Dr. Huntingdon's case, sub-periosteal resection of the tibia had been performed for infective osteo-periostitis, and in each case the limb was useless. "An incision was made in the original scar in its lower half and the deeper tissues retracted so as to form a suitable furrow for the reception of the bone-graft. Another incision was made over the lower third of the fibula and the superficial structures separated from the bone and periosteum. A segment of bone, about two inches long, composed of half the thickness of the fibula with its attached periosteum, was split off by a chisel, and laid in the prepared furrow." When the dressings were first changed at the end of two weeks, the wound was found to be suppurating. Small crumbs of bone came away, but the wound gradually healed well. About nine weeks after the operation the tibia was rigid in its whole length, and abnormal movements could no longer be performed. Skiagraphs taken at intervals showed increasing thickness and density of the tibia. Seven months after the transference of bone, the boy was able to walk quite well, although there was some shortening of the leg. This method deserves extensive trial. Two points especially need attention: (1) Thorough sterilisation of the bed for the graft; (2) attention to the position of the foot and support to the tibia, while this is solidifying.

Filling up of bone-cavities.—The following methods are available here. In all it is absolutely essential that the cavity be devoid of infection of any kind. The circumjacent area must be regularly re-sterilised from time to time.

1. By detaching flaps of skin and soft parts and so "papering" the cavity which must be first carefully freshened. This method may be aided by skin-grafting. It has been alluded to at p. 962. If any portion of a muscle has formed part of the soft tissues used, adhesion of this to the cavity and subsequent interference with its action must be prevented by passive and active movements being begun two or three weeks later. The limb should not be used until six or eight weeks have elapsed.

2. By the use of decalcified bone. The cavity having been carefully refreshed, and the periosteum if possible detached, the cavity is entirely filled up with the decalcified fragments over which the periosteum and soft parts are, separately, drawn together, if this be possible.

3. By various "fillings." Most of these have proved failures. The following account of the method of v. Mosetig inserted by the editors, Dr. W. T. Bull and Dr. J. B. Solley, in the third volume of their translation of v. Bergmann's *System of Surgery*, p. 703, is worthy of careful attention. "The method as reported by v. Mosetig (*Münch. Med. Woch.*, 1903, No. 2) before the Gesellschaft für Aertze, in Vienna in January of the same year, and which he had used during the previous

three years, in over a hundred cases of caries and necrosis, was as follows: Under application of the Esmarch and with strict antisepsis the periosteum was lifted off and all diseased tissue removed thoroughly with sharp spoon, &c., until positive that the cavity was aseptic. The result depended upon the latter condition and the sterility of the filling. The filling consisted of iodoform, 60.0; spermaceti and oleum sesami, $\text{â}\text{â}$ 40.0, heated slowly to 100° C. in a flask on a water-bath; kept at this temperature for fifteen minutes; then removed and allowed to cool and solidify, while shaking constantly. Before using, it is melted and heated to 50° C. in a thermostat. After the cavity has been cleansed of all diseased tissue, it is washed out thoroughly with a 1 per cent. solution of formalin, dried out with swabs and then with hot air and filled with the melted mixture. The periosteum and skin are then sutured without drainage and a dressing applied. In fourteen days the dressing is changed and the skin sutures removed. The course is almost afebrile, and there is never iodoform intoxication. The hardened filling is gradually replaced by granulations and new bone as demonstrated by the X-ray (Holzknecht). The patient can be about. The size of the cavity, according to Silbermach (*Münch. Med. Woch.*, 1903, No. 20) is no contraindication, in some instances two-thirds of the shaft having been removed and replaced by the filling. The same author emphasises (*Centr. f. Chir.*, 1903, No. 25) the importance of absolutely checking all bleeding and drying out the cavity with hot air, and describes the electrical hot-air apparatus used in v. Mosetig's clinic (*Deut. Zeitsch. f. Chir.*, Bd. lxxi., p. 589). To check the oozing of blood even more surely, Damianos (*Centr. f. Chir.*, 1904, No. 6) swabs out the cavity with adrenalin pledgets after thorough cleansing and drying with hot air. He cites 150 cases treated successfully, and attributes the results to extreme care in the technic and in determining the time of operation. According to Damianos, v. Mosetig prefers a flap section to direct incision. In chronic osteo-myelitis the cavity can be plugged at once, but in acute cases not until several weeks after the onset."

SARCOMA OF FEMUR AND TIBIA.

The myeloid and endosteal variety has been referred to in Vol. I., p. 91, in the surgery of the bones of the forearm. In that region resection was the chief operation in question, here it is amputation or scooping out of the growth.

In the femur, when the sarcoma is periosteal, amputation at the hip-joint by skin flaps and division of all the soft parts as high as possible is usually the only operation available. It is possible that the use of the Röntgen-rays may by rendering an earlier diagnosis possible, improve the prognosis which is at present so grave owing to the probable existence of metastases. In the endosteal variety affecting one condyle, scooping out of the growth, resection of the bone affected and excision of the knee have all been performed, but the risk of reappearance of the disease and the doubtfulness as to the utility of the limb render amputation which is usually sufficient if performed high up in the thigh with careful inspection of the medullary canal, a preferable step. But here, again, the Röntgen-rays if employed early,

and aided by a free exploratory incision made without delay, may increase the possibility of saving the limb.

In the tibia and fibula, where the sarcoma is endosteal, from the presence of two bones and the somewhat simpler access, resection of the bones and scooping out of the growth have to be considered as well as amputation. Mr. Morton has resected the knee joint in two cases (*Brit. Med. Journ.*, 1898, vol. ii. p. 228). The after use of the limb was good. As stated in Vol. I., p. 92, long duration, slow progress of the growth, uniformity of expansion, no evidence of increased size of the shaft, indicating extension along the medulla, or of escape of the growth into the soft parts are amongst the chief points to bear in mind when any of the less radical operations are performed. The Röntgen-rays may not only be of assistance in clearing up early a doubtful case, but also in showing the degree of thickness of the bony capsule as indicated by a darker zone contrasting with the adjacent lighter area, and whether the growth has perforated externally. Egg-shell crackling and pulsation are more often talked of than seen.

In the operation for scooping out—it is rarely an enucleation—the following points may be of service. The parts having been duly sterilised, and the hæmorrhage controlled by an Esmarch's bandage, the growth is exposed by a sufficient flap or longitudinal incision on the aspect which gives the best access. If the periosteum be not infiltrated, it should be raised, care being taken not to rupture the capsule. With stout scissors or a chisel this is next freely opened. If it be possible the growth is now enucleated entire. But its friability and its adhesions render this rarely possible. The only mode of removal is usually that by sharp spoons. During their use the capsule must not be perforated, and cavities accessory to the main one should be looked for. Hæmorrhage now may cause much trouble.

In a case operated upon by Dr. J. C. Bloodgood (John Hopkins Hosp., Bull., May 1903, p. 134), the shell was found to be perforated by 25 or 30 vessels as large as the temporal artery. Each of these openings was plugged with Horsley's wax. No return of bleeding took place, but it was two weeks before all the wax was removed. The history of the case is only carried up to three months after the operation.

Where the result of the scooping out appears doubtful, the cautery, pure carbolic acid, or a strong solution of formalin should be tried. The wound is plugged with strips of gauze. The long process of healing of the cavity where this is large may be hastened by one of the steps given at p. 1009.

Even where there is no local reappearance, the above operation may fail owing to metastases, or to the shell left being too weak to support the leverage of the parts below or the weight above. Where a free exploratory incision has proved that the endosteal sarcoma is a mixed one—and these growths are by no means always myelomata—amputation through the knee-joint or the lower third of the thigh is the only course. Owing to the aggravated disappointment which attends a local reappearance after an amputation, I prefer the latter step. And this operation is the only one in periosteal sarcomata of the bones of the leg,

TREATMENT OF COMPOUND FRACTURES.*

The following **special points for consideration** arise here—viz., (1) The treatment of the wound; (2) The reduction of protruding fragments and the treatment of splinters; (3) Complications; (4) The question of amputation.

(1) In the *treatment of the wound* the one great object is to convert the fracture as soon as possible into a simple one. In a few cases, sealing a small, *clean cut* wound, the skin having been carefully sterilised, at once with dry gauze, and collodion and iodoform, or tinct. benz. co., may be sufficient. But where the surgeon's surroundings admit of it, and where there is reason to be suspicious about the soil at the spot where the injury took place, it will be better to make an incision and disinfect the ends of the bones. In those cases, common enough in large hospital practice, where the wound is extensive and lacerated, and accompanied by great contusion of the soft parts, with abundant blood extravasation, with much comminution of fragments and injury to the periosteum, or where the fracture is complicated with a dislocation, the following method will be found to give the best results.

(2) *Protrusion of Fragments.*—It is usually the upper one which protrudes. The difficulty of reduction is in proportion to the obliquity of the fracture, the length of the protruding bone, and the amount of spasm. The wound having been freely enlarged, an attempt must be made by manipulations to bring the fragments into accurate apposition. This will often be facilitated by means of a strong elevator inserted between the fragments, and used as a lever. Division of the tendo Achillis or possibly of other tendons may also be found necessary before satisfactory reposition can be accomplished. Failing all these, part of the bone must be removed with a narrow-bladed saw, care being taken to separate the periosteum first, and to protect the soft parts with a blunt dissector passed under the bone and by retractors. If the bone is splintered, some judgment is required as to what pieces to remove. Those which are still adherent by their periosteum should be left. Those completely torn away must be removed, whether they carry their periosteum or not. As to a third set partly adherent, partly not, these, as a rule, partially die in proportion to the injury to their periosteum, and keep up for a long time irritation, and delayed union with, perhaps, suppuration, &c. They must, therefore, as far as practicable, be removed. If after reduction it is found that there is any considerable tendency to the reproduction of the deformity, the fragments must be fixed either by means of silver wire, steel screws, &c., as suggested by Mr. W. A. Lane (*vide* p. 1017), the choice between these methods depending upon the conditions present and the practice of the surgeon operating.

While an anæsthetic is given,† the parts are widely and thoroughly cleansed with turpentine or liquor potassæ, hot soap and water, and warm 1 per cent. lysol solution. In the case of the leg, the razor and

* From the frequency with which these occur in the leg this subject will be treated here.

† No probing or other examination is to be made until the limb has been cleansed.

nail-brush should be used from the toes to above the knee. Any skin which is much damaged or into which dirt has been ground is first cut away. The wound having been freely enlarged and all recesses well opened up, the blood-clot is washed away and the whole surface of the wound thoroughly sponged over with swabs (of gauze, not wool), soaked in hot carbolic acid solution (1 in 30) or biniodide of mercury (1 in 2000). Where many recesses exist, especially if out of sight, one of the above solutions warmed should be introduced gently with a syringe,* a sterilised gum-elastic catheter and short piece of tubing and funnel. An additional source of safety may be the use of pure carbolic acid to any infected tissues or the bones themselves. Where dirt has been ground into the fragments, this must be gouged out or shaved off with a stout knife. The fragments are now reduced (care being finally taken that nothing intervenes) and fixed, if needful, as described at p. 1020, and counter-openings made for drainage as may be found necessary. The Esmarch's bandage should not be removed until there has been time for the antiseptics used to soak into the parts; all hæmorrhage being now arrested, and any torn nerves pared and sutured, the recesses of the wound are well dried out; sterilised iodoform† is then dusted in, sterile dressings applied or a boracic acid fomentation according to the confidence which the surgeon is able to feel in the disinfection of the wound, and the limb put up either in a back and two side splints with any needful interruptions, or, according to Mr. Croft's directions, in plaster of Paris. Another excellent means of using plaster of Paris is in combination with metal strips so as to easily provide good access to the injury. A sterile bandage is first applied below and above the wound, two to four strips of thin malleable metal are then applied antero-posteriorly and laterally as well if needful, bent outwards over the area adjacent to the fracture, their extremities being embedded in the plaster of Paris bandages as these are applied. Of the above I prefer the first and the third, in severe cases, for the first week; infrequent dressings, wherever practicable, are most essential. But in

* Vigorous introduction of fluid may drive infected blood clots or dirt deeper in.

† This most valuable drug is not sufficiently used in these cases. I may briefly mention three cases in which limbs were, I think, saved by it. One was a very severe compound fracture of the femur in a man, aged 46, who fell twenty-two feet on to the banks of the Thames, striking a stone buttress as he went down. I saw him about an hour after the accident. The fragments were much displaced and overlapping, the lower one being also split vertically, but not so far as the knee-joint. The ends of both were bare, and the vastus externus and hamstrings were lacerated, the injury having been made greater by the patient having been lifted off the mud on to which he fell into a boat, and then into a cab. Ether having been given, the external wound, through which the vastus externus protruded, was freely enlarged, and its recesses well washed out with 1 in 30 carbolic acid solution, as advised above. About 3j of iodoform was then carried down right between the fragments by means of the finger and a narrow spatula, and two large drainage-tubes inserted. An aseptic result was secured from the first and maintained, throughout, by the dresser (Mr. J. H. Lister), the man making an excellent recovery. The second case was that of a compound comminuted fracture of the leg, with wound of the anterior tibial artery (mentioned at p. 997). The third occurred in a boy with compound separation of the lower epiphysis of the tibia, in which two inches of the protruding diaphysis were removed. The case did so well after the introduction of iodoform and the other precautions already given, that the first dressings were not removed till the eighth day, and the lad recovered with an excellent limb.

trying to secure this end, the risk of shutting in infection must not be forgotten.

(3) *Complications*.—My space will only allow me to enumerate these. They are local and general. The former include pruritus, vesicles, ecchymosis, suppuration, œdema, phlebitis, gangrene, osteitis, caries, necrosis, muscular spasms, dislocations, and implication of a neighbouring joint. The general complications are such as are common to all injuries—viz., traumatic fever, delirium, erysipelas, septicæmia, pyæmia, hectic, tetanus, jaundice, and retention of urine; in older patients a tendency to hypostatic congestion and broncho-pneumonia, and finally, in a few cases, pulmonary fat-embolism.

(4) *Question of Amputation*.—The following are amongst the conditions requiring primary amputation: (1) When a limb is torn off by a cannon-ball, a portion of shell, or by machinery. (2) When the division of the soft parts is nearly complete, except in the case of a clean cut across the phalanges, metacarpus, or metatarsus; even the forearm may occasionally be saved under similar circumstances. (3) When there is much actual loss of soft parts, as when one side of a limb is torn away, or the skin is extensively peeled off. (4) When, with or without great comminution of the bones, there is much bruising and laceration of the soft parts, with protrusion of muscular bellies, and extensive tearing up of deep planes of areolar tissue. (5) In some cases when the principal artery and nerves of the limb are both divided; thus, in the case of the lower limb, primary amputation will usually be required. (6) In certain cases of severe hæmorrhage, primary or secondary. On this subject I must refer my readers to the remarks already made at p. 992. (7) Some cases of compound fracture of large joints—viz., when one bone is shattered or more than one is broken; when there is much laceration of the ligaments; when, in addition to comminution of the bones, there is much contusion of the soft parts, especially if complicated with division of an artery; when the foreign body which has caused the fracture remains in the joint, or, projecting into it from its bed in the bone, cannot easily be removed, or when there is much damage to the articular surfaces. It will be understood that all these forms of injury are most fatal when affecting the knee or hip; in dealing with other joints much greater latitude may be allowed.

Finally, before deciding on amputation, the surgeon must take into consideration, in addition to the above points which concern the fracture itself, any general information to be gained about the patient himself. Thus, the age, constitution, habits, any sign of visceral disease, and the appearance of the patient, are all points of material importance in coming to a decision between amputation and an attempt to save the limb. Thus, to make my meaning clearer, there are no more anxious cases than severe compound fractures in dwellers in large towns, who are past middle life, flabbily fat, with dilated venules about the cheeks and nose, whose conjunctivæ are slightly jaundiced, the urine of low specific gravity and perhaps albuminous.* The surgeon must here bear in mind that saving the patient's life is, after all, of more importance than the preservation of his limb.

* Note will also be taken of the occupation, as in brewers' draymen and commercial travellers.

In performing amputation in these cases of compound fracture it is always to be remembered that the injury is not so localised as would appear from the surface (footnote, p. 935); thus, in compound fracture of the leg there is often extensive loosening of the skin from the deep fascia, and extravasation of blood into the deep planes of connective tissue for some distance above, the knee-joint being perhaps full of blood, and its cartilages bruised. In such cases, if amputation be performed just above the injury, sloughing and separation of the flaps will inevitably follow. On the other hand, in cases of severe compound fracture of the thigh, where amputation is required high up, it will be found better practice to amputate, in part at least, through injured tissues.*

If, in addition to the fracture, there are serious injuries to other organs, immediate amputation is useless or injurious. The only chance of recovery here is afforded by secondary amputation after the early dangers are past.

Secondary amputation may be required for profuse suppuration with hectic, for gangrene, or uncontrollable hæmorrhage. The decision must here be made according to the needs of each case. The surgeon must, if possible, wait till the infective fever and constitutional disturbance are subsiding, till the temperature has begun to fall, and till all redness, erysipelas, and sloughing have ceased. On the other hand, if the operation be deferred till the powers of the patient are running down from profuse suppuration and hectic, and till confirmed asthenia has set in, the period of performing it will, very probably, have passed away.

At a still later period the operation may be desired by the patient, if, in consequence of non-union, incurable deformity, or tedious bone disease, the limb has become an encumbrance to him. Some of these conditions may, of course, be treated by resection, osteotomy, &c.

OPERATIVE TREATMENT OF SIMPLE FRACTURES.

The wider adoption of this step has been strongly advocated by Mr. W. A. Lane (*Clin. Soc. Trans.*, vol. xxvii.; *Clin. Journ.*, July 1897, and elsewhere), on the grounds chiefly that (1) it is perfectly safe nowadays, (2) that otherwise the results are often bad and very frequently disabling, and (3) that it is a saving of time.

(1) At the present date the opinion of most surgeons is that it is only in a small proportion of cases of fracture of the leg and Pott's fracture—conditions which will be considered separately—that operative interference is justifiable, for the following reasons. The value of any treatment, especially in a very common injury, must be estimated by the extent to which it is available by the great majority of those called upon to employ it, or to put the matter in Sir W. Bennett's words

* Thus, in the case of a young railway porter, whose thigh was smashed by a railway accident at Epsom, I performed amputation at the level of the lesser trochanter, in preference to the hip-joint. The damaged flaps sloughed, as I expected, but the patient made a good recovery, after the removal of some dead bone. All the precautions which may be taken against shock before, during, and after the amputation, will, of course, be adopted in these cases.

(*Treatment of Simple Fractures*, p. 16; and *Brit. Med. Journ.*, Oct. 7, 1900): "It is quite impossible—and this is a fact that cannot be too strongly insisted upon—to estimate the value of any method of treatment upon the evidence of the report of the successful cases only. It is equally impossible to gauge the general value of any method of treatment upon the experience of a few individuals. Although a certain number of surgeons may be able, from the circumstances in which they work, or from special aptitude in operating, to produce results which are practically ideal, it does not necessarily follow that the same result can be achieved by the general body of those who attempt the same method." I need not point out that while the skin in these cases of simple fracture of the leg is unbroken, it is very often in a condition which renders it impossible to say that operative interference is, even nowadays, without risk. At the usual site of fracture it is thin and of little vascularity, its vitality is diminished by the injury; blebs and extravasation may be present. The needed thoroughness of the sterilisation can only be secured at the risk of further damage. Moreover, the patients are often habitually inattentive to cleanliness, and drunken habits may be a further complication.

(2) In my opinion the proportion of cases in which the use of the limb has been permanently impaired and the wage-earning capacity of the patient seriously diminished has been much exaggerated. To get at the truth, I consider it essential that in such cases the patient should be examined as to the accuracy of his statements by the surgeon himself. Written reports from patients have little value in my eyes. The patient's powers have to be tested by experienced and watchful eyes, and the influence of club-money and expected remuneration from actions at law to be duly weighed. That the real disability is small is confirmed by such results as Sir W. Bennett (*loc. supra cit.*, p. 22) obtained from his enquiries amongst practitioners in mining and colliery districts, and those who had to do with sailors in large numbers who have suffered from fractures at sea and under other disadvantageous circumstances. On this point Sir William speaks as follows:—"The result of my enquiries in this respect is that I find the real disability following upon fracture is not so great as one would be led to suppose from recent writings on the subject." . . . "The fact of the matter is, I believe, as follows. In spite of what may be said to the contrary, the disability following upon fracture is much more frequently due to matting of the parts about the fracture and about the joints immediately concerned than to faulty union of the bones themselves." . . . "I believe that if in cases of fracture early passive movements were methodically used so that all chance of adhesion of the parts is prevented, very much less would be heard about the disabilities in such cases than we hear now." Mr. R. W. Murray, Surgeon to the Northern Hospital at Liverpool in a paper on "The Ultimate Results of Eighty-eight Cases of Fracture of the Tibia and Fibula" (*Brit. Med. Journ.*, Oct. 10, 1903) writes, "In the vast majority of the cases of oblique fracture the men were able to resume their former work." While the subject of the function of the limb is being referred to, I would remind my readers that though the functional results of non-operative treatment may be excellent the Röntgen-rays may reveal the persistence of a marked deformity. As to the gain of time by

operative treatment in simple fracture of the leg this is certainly not so marked as in fracture of the patella. The screw, while an excellent means of holding the fragments together, frequently requires removal, and in future as the early use of passive movement, which Sir W. Bennett has advocated so strongly, becomes more general, the time required before the patient's employment is renewed will be materially shortened.

Indications for Operative Interference in Simple Fractures.—

A. Those cases of spiral or oblique fracture in which careful attempts guided by radiography have failed to satisfactorily reduce the displacement; or where reduction is effected, but on the patient's recovering from the anæsthetic the fragments slip apart. In the rare cases where crepitus is noticed to be absent, a suspicion of intervening soft parts would arise, justifying exploration. B. Some cases of Pott's fracture. The general health, vitality, and habits of the patient must be satisfactory, and the surroundings such as to ensure an aseptic result being secured.

A. **Operation.**—The entire leg, foot and toes are most carefully prepared (p. 1012). Any blebs should be incised, and pure carbolic acid applied. The exposed surface should be dusted with

FIG. 434.



sterilised aristol while the compress is on. The sterilisation should be carefully repeated when the patient is anæsthetised. The fragments are best exposed by a longitudinal incision over the superficial aspect of the tibia: a flap is more likely to further interfere with the vitality of the parts (p. 1016). Any intervening blood clot or muscle or fascia having been removed, the fracture is reduced, often a matter of much difficulty. While extension and counter-extension are made by assistants, the surgeon prises the fragments into their correct position by means of a strong elevator and lion-forceps, any comminuted fragments which admit of it (p. 1012) being accurately fitted into place. If it is necessary to remove part of either fragment the periosteum must be detached; otherwise this membrane is left carefully *in situ*. While the corrected position is maintained by lion-forceps,* or extension and counter-extension, the fixation is carried out. Mr. Lane's screws (Fig. 434) are an excellent means of effecting this. They are of silvered steel, long, and practically of the same width throughout: the thread is a wide one and the head small, so that a small cavity in the bone suffices for its reception. A series of drills or bradawls should be at hand, and the one selected should be slightly

* Peter's modification of these which allow of screws, &c., being passed through the jaws while these are holding the fragments firm are most useful.

smaller than the screw. Both fragments are then drilled obliquely and together, and when this is done the holes should be sufficiently far from the ends of the fragments to prevent any splitting of the bone. As a further precaution against this the upper part of the drill-hole should be enlarged with a reamer (Fig. 435) of the same size as the shank of the screw. A cavity should also be made with a small gouge or burr to receive the head of the screw. As this is finally driven home it should be felt to draw the fragments together and to lock them firmly. Other means of fixation are referred to in the next section. The wound is then thoroughly dried out: the amount of drainage and the number of sutures indicated depend on the condition of the soft parts, superficial and deep. And the same factors in the case will decide whether dry dressings or a boracic acid fomentation are employed. As screws, after fulfilling their function, are liable to cause trouble such as localised suppuration, sinuses and necrosis, it may be after a long interval, it is well to remove them about six weeks after the insertion. If secure, they require to be unscrewed.

B. Pott's Fracture.—The occasional severely crippling and disabling deformity of pes valgus which may follow eversion-fractures is well known, and certainly calls for remedy by operation. But if these

FIG. 435.



injuries were only treated with "brains," if the nature of a Pott's fracture were remembered with the displacement of the foot backwards as well as outwards, the rapid and large effusion, the parts implicated thereby, and the tendency to look upon these injuries as severe sprains, the need for such interference would arise very rarely indeed.

Owing to the calls on my space cases of recent origin and those of longer standing will be considered together. For compound fractures or separation of the lower epiphysis of the tibia the remarks at p. 1012 should be referred to.

Operation.—It is only in recent cases up to about the third week that forcible correction, by manipulations aided by a wrench will be of any avail. Where this fails to place the foot in an over-corrected position, a point as essential as in talipes, some modification of osteotomy may suffice. Thus the fibula is exposed by a longitudinal incision over its lower part, and the bone either refractured or better divided transversely with a chisel, care being taken of the periosteum. If correction is impossible a curved incision is made freely over the internal malleolus, the tibia exposed by separation of the periosteum and soft parts, and a wedge, the size of which is proportionate to the deformity, cut out with a chisel, the bone not being completely divided. By fracturing the remaining portion over-correction can generally be effected. Further steps which may be needed are division of adhesions about the internal malleolus, or removal of this process or redundant

callus where mal-union has taken place. If any equinus position persist, the tendo Achillis should be divided. In some cases an oblique osteotomy of the fibula is preferable to a transverse one, by allowing better of shifting of the fragments, and the same step with a similar object may occasionally replace the cuneiform osteotomy of the tibia. Removal of the lower end of the fibula, while facilitating greatly the needful inversion is never permissible in patients of the age at which this fracture occurs: the after-stability of the foot and secure walking are liable to be seriously interfered with. Drainage should always be employed, and most of the sutures inserted should be left untied for the first few days. Back and side splints are, in my opinion, greatly preferable to plaster of Paris at the first, if the right-angled position of the foot is to be maintained.

The patient must be prepared to take his just share of the responsibility as to the result by helping in the needful passive movements and massage, early, and, as soon as the union is sufficiently firm, by undertaking those of an active kind.

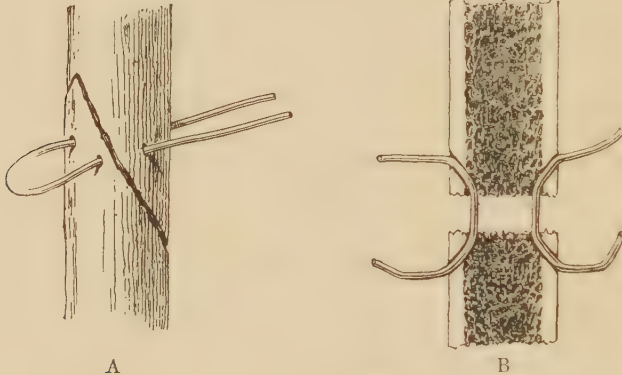
UNUNITED FRACTURES.

Recent years have shown that operative interference has made here no real advance as to certainty of result which is proportionate to the progress of modern surgery. The methods of fixation have increased in number. But while, theoretically, these are full of promise, in practice failure is still common. The chief addition to our knowledge is the information which the Röntgen-rays may give as to the condition of the ends of the bone or bones, the direction of the line of the fracture, whether oblique or transverse, how far they are symmetrical, the amount of separation, and, especially, how far they are normal or expanded, or atrophied. By the information thus gained the surgeon is aided in his selection amongst the different methods of fixation.

Operation.—While the following remarks have been inserted here for the sake of convenience, they apply not only to the bones of the leg, but also to the humerus and femur. It may be useful to refer to the best mode of access to the humerus (Vol. I., p. 160), and that to the femur (*supra*, p. 943). While the tibia offers a subcutaneous surface on its inner aspect which invites attack, its outer aspect can be safely reached by working within the detached periosteum. While this hint applies to other bones with important structures lying on one aspect it must not be taken to sanction needless detachment of the above membrane. The limb must be emptied of blood and an Esmarch's bandage applied. In making his incision the surgeon will be guided by the information given by the rays. If a flap be preferred, the objections given at p. 1016 to this method do not apply so strongly here, where the vitality of the parts is better and thorough sterilisation more easily secured. A free longitudinal incision usually suffices. The remarks at p. 1017 apply to the exposure of the fragments. These are next sufficiently refreshed by the removal of any scar tissue, &c., with a chisel and mallet or bone-forceps; a thin slice is then removed from each fragment, and if they lend themselves to mortising or stepping (*vide infra*), they are shaped accordingly. They are now brought in apposition, especial precaution being taken as to faulty rotation of the

lower fragment, partly by extension and counter-extension, partly by manipulation with powerful elevators or forceps. Much difficulty may be met with where one fragment is depressed and firmly embedded in the soft parts, and the needful disturbance of these may be great in spite of much ingenuity and patience. Any tense bands which interfere with the replacement must be detached or divided, after due examination of their possible contents. Thus in the case of the humerus the

FIG. 436.



A. An oblique fracture.

B. A transverse one. (Cheyne and Burghard.)

musculo-spiral nerve must be remembered. To retain them in place the following *methods of fixation* are available.

1. *Screws*.—The use of these, especially indicated where the fracture is known to be an oblique one, has been described at p. 1017.

2. *Wire* (Fig. 436).—While this material does not give a hold as firm as does a screw, and while, if used in the ordinary way, it involves more complete exposure of the fragments, it is the material with which

FIG. 437.



(Walsham.)

FIG. 438.



(Walsham.)

the majority of surgeons are most familiar; it is always available, and, if it gives after-trouble, it is more easily removed than a screw. When its use is preceded by drilling, Figs. 436 and 437 illustrate useful methods in the case of an oblique fracture, and Fig. 436 that when the fracture is transverse. In the latter case the use of two wires when practicable is always advisable. While this step is not essential, where it has not been employed greater care is always needed in the application of splints or plaster of Paris (p. 1013). I do not consider the use of drilling—always the most difficult and prolonged part of the

operation—as necessary. One, or better two, encircling wires will often suffice (Fig. 438). To give an additional hold the bone may be notched as there shown. The wire is more easily embedded if it be passed outside the periosteum. In three cases of fracture of the humerus, the use of a single wire led to an excellent result; while in one, when I last saw the patient, union was not complete, the patient had resumed his work as a miner. However the wire is employed, its ends should be cut short, after the twisting, and embedded. The wire should be soft. The most useful sizes are Nos. 5 and 6, French gauge. By some iron wire is preferred, but I have seen nothing to lead me to believe that troublesome after-effects are influenced by the material of the wire employed.

3. *Ivory Pegs*.—The objection to these is that they soon work loose. According to Watson Cheyne, C.B. and Burghard (*Man. of Surg. Treat.*, pt. iii. p. 52) this can, to some extent, be avoided by using square pegs. Care must be taken in driving them home not to damage the soft parts or break off the peg.

4. *Senn's Bone Ferrules*.—(*Amer. Journ. Med. Sci.*, 1893, vol. ii. p. 125). These are theoretically ideal. They not only hold the fragments well in place, but afford a scaffolding along which reparative material may travel. They are not always available, and difficulty in satisfactorily ensheathing the second fragment is liable to occur.

5. *Aluminium Perforated Collars or Plates*.—These are recommended by Messrs. Watson Cheyne, C.B. and Burghard (*loc. supra cit.*) in cases where lateral displacement is a marked feature, or where a tendency of the lower fragment to rotate is difficult to meet. If the bone be cylindrical a partial collar encircling about three-fourths of the circumference is employed; in other cases two narrow plates are inserted, one on either side of the bone. In either case they are secured with nickelled tin-tacks.

6. *Dovetailing or Mortising the Fragments*.—Very occasionally, the condition in which these are found lends itself to cutting them into step-like shape, or zig-zag fashion, so as to secure better interlocking. They are thus secured with a screw or peg passed horizontally or vertically, a ferrule or aluminium plate.

7. *Gussenbauer's Staple* (Fig. 439).—This very simple method deserves a wider knowledge in this country. If any sinus form, and the staple give evidence of becoming loose, the adjacent skin must be kept sterile.

8. *Bone-Grafting*.—This subject has been referred to at p. 1009. Here the graft is best taken from the bones themselves. In the case of a single bone a portion covered with and still connected with its periosteum, if possible, is chiselled off and jammed in between the freshened fragments. This fixity is essential as no wire, &c., can usually be employed. In the case of two bones, where the intact condition of one prevents the approximation of the fragments of the other, the graft is best taken from the unbroken bone (p. 1009). In other cases the bone has been taken from a distance, as in Sir W. Macewen's case (Vol. I. p. 159), where the wedges removed in osteotomies were

FIG. 439.



Gussenbauer's staple
(v. Bergmann's Surgery).

employed. As the method of bone-grafting is chiefly indicated in the less promising cases where the ends are much atrophied or widely separated, too much must not be expected from it. Scheuer has met the difficulty with brilliant success in a severe case of pseudarthrosis of the humerus in a boy aged four. After refreshing the ends of the bone he implanted a flap from the thorax containing a piece of the fifth rib. Bony union followed, and the pedicle was divided fourteen days later (v. Bergmann's *Syst. of Surg., Amer. Trans.*, vol. iii. p. 138). In the case of the lower extremity, it might be possible to follow this example by taking the bone from the opposite limb.

As before stated, the question of drainage, and the extent to which it is advisable to close the wound at once with sutures, must depend on the amount of disturbance inflicted on the parts. Complete closure of the wound looks admirable at the time, but may well entail too much risk. From his knowledge of anatomy and the size of any vessels divided the surgeon should decide as to whether it is safe to leave the removal of the Esmarch's bandage until the dressings are *in situ* (p. 959), a course always to be followed if possible.

EXCISION OF VARICOSE VEINS.

This method, as old as the times of Celsus, and one which fell into disuse from the risks of pyæmia, &c., was revived with safety some years ago by Mr. Davies-Colley (*Guy's Hosp. Rep.*, 1875, p. 431), when Lord Lister had shown how the old dangers might be avoided.

Indications.—Safe as this operation has been made, it is to be recommended with caution owing to the great risk of recurrence. If this operation is largely employed, and the cases are carefully watched, it will be found after some years that the amount of permanent benefit ensured is, in many cases, very small. I allude especially to operations performed below the knee only (*vide infra*), or to those cases, often of markedly diffuse varicosity, where small multiple incisions, thirty to fifty, are made on the two limbs.

Operative interference here requires more discrimination than it has received either by surgeons or patients. The public look upon operation here as not only absolutely safe, but as equally certain to bring about a cure. Any surgeon wishing to maintain a character for honesty will consider this claim to be a most harmful exaggeration. While operation in well chosen cases will remove many discomforts and certain sources of danger, it is extremely rare that it enables the patient to dispense entirely with the need of further attention to his veins.

Before the varices are removed it must be ascertained that the better supported deep veins, through which it is intended that the blood shall largely return after the superficial ones are obliterated, are healthy.* The cases best suited for operation are: (1) Where only one vein-trunk is involved, at one or two definite parts of its course. (2) Where both saphenous veins are involved, but again definitely and locally. The more the varices are longitudinal, the more they lie in the lines

* A full, tumid condition of the calves, with cramp-like pains here, points to a varicose state of the sural veins, and is against operation; so too are any tendency to cedema, or increase in the size of the limb.

of the trunk, the more longitudinal incisions will suffice, the more satisfactory the operation and the better and more lasting the results. On the other hand, where the enlargement is bilateral and general, where numerous communicating veins between the trunks are enlarged, where the venous radicles are becoming dilated and their ramifications plexiform, the more, in short, that the disease shows signs of being a general one, the more will the result be disappointing. Finally, the soft parts near the varices should be in a healthy condition, free from

FIG. 440.



Case of varicose internal saphena vein with dermatitis and ulceration below. From the ulcer severe hæmorrhage had occurred. I saw the woman three years after the operation on the varicose veins, and she remained well, but I have lost sight of her since.

dermatitis, and thus capable of being rendered aseptic, and of uniting quickly afterwards. In a few cases, though the conditions given above as essential for success are absent operation is still indicated. (3) Where many varices exist, but one is especially troublesome, as where a very thin-walled vein crosses the tibia in an exposed position in a young adult, to whom playing football, &c., means very much; or where a varix is the cause of an ulcer troublesome to heal, and, perhaps, already the source of dangerous bleeding (Fig. 440). (4) In some cases of thrombosis. Where a patient is the subject of thrombosis in "the dangerous area" (*vide infra*) and the thrombus is creeping upwards a surgeon who can rely on the case running an aseptic course is quite justified in placing a ligature on the proximal side of the thrombus with the view of preventing its reaching the large trunks. How far it is wise for him to go further and remove the thrombus at the same time or later with the object of preventing implication of the deep veins and a recurrence of the thrombus must depend on the individual case. Sir W. Bennett ("Varix and Thrombosis," p. 49) goes further and considers that in a certain number of cases of thrombosis followed by embolism "incalculable good can be done by surgical means provided that action is taken speedily and boldly." Thus if a thrombus in the "dangerous area" (*vide infra*) shows signs of softening, if one or two attacks of cardiac pain and dyspnœa have occurred, removal of the source of the emboli, or interruption by ligature of the channel by which they have reached the central parts, and by which they may produce another and a fatal attack is called for.

I shall describe two operations. (1) That by which the "dangerous area" of Sir W. Bennett is removed; (2) that of Trendelenberg. I have used the first largely and my experience justifies my saying that I consider it to be the one most suitable to the largest number of

cases in which an operation is justified, and one which is least likely in its results to lead to disappointment. Sir W. Bennett (*loc. supra cit.*, p. 18), has given the term "dangerous area" to that part of the inner aspect of the lower limb "which is marked off by two transverse lines, one about the middle of the thigh, and another three inches below the knee-joint, an area in which the local conditions predisposing to thrombosis in varix are present in a remarkable degree. Cysts, often of great size, huge dilated tortuous vessels, valveless and with abrupt bends are frequent, and are constantly being subjected to the straining movements produced by flexion and extension of the knee." A little later Sir William writes: "Speaking generally, if the disease is confined to the leg, operation is useless; sometimes it is harmful." And again, "operative measures confined to the parts below the knee in general varix are useless."

Operation.—The skin of the limb or limbs must be first carefully sterilised, and if the operator for any reason is likely to trench upon the back of the limb, this area with its thicker skin must not be forgotten. This step having been completed, the patient should stand in order to distend the veins, the outlines of which are then marked on the skin with sterilised carbolic acid fuchsin solution applied either with a sterilised camel-hair brush or a match-stick. The usual compress is then applied. When the patient is placed on the table the limb should be allowed to be dependant while the anæsthetic is given, and if both limbs require removal of the "dangerous area" this can be done simultaneously by two operators, if the limbs be well abducted, everted and rotated outwards. An incision is made from above downwards over the above mentioned area starting in the middle of the inner aspect of the thigh, and the dilated saphena vein exposed by light touches of the knife. Fine sterilised silk having been passed by an aneurysm-needle around the vein in the upper angle of the wound and Spencer Wells's forceps applied a little lower down, the ligature is secured, cut short and the vein divided. Then the operator, dragging gently on the forceps, exposes the vein gradually by prolongation of the longitudinal incision down to the middle of the leg, dissects the vessel out at this point, where another ligature is applied in the lower angle of the wound, and the varix removed. Any branch-veins which have been clamped with forceps are now tied, and it will shorten a prolonged operation if when the upper half of the vein has been dissected out, a trustworthy assistant, standing above the operator and on the opposite side of the limb, begins to close the long wound with sterilised gossamer salmon-gut sutures. I will venture to draw the attention of my younger readers to the following **cautions**. (1) The strictest aseptic precautions will, of course, be taken throughout by all concerned. (2) The frequency of a collateral trunk or a double internal saphenous vein in the thigh must be remembered. When such a condition is present the vessel usually lies superficial to the parent trunk; if the latter be healthy, it may need no interference (Davies-Colley, *loc. supra cit.*). (3) Every bleeding point should be carefully tied, otherwise tension may occur, with undermining of the edges of the wound with blood clot and delayed healing. (4) The ligatures should be of the finest and most thoroughly sterilised, otherwise they will work out vexatiously, a result rendered the more

probable if the patient persist in getting about too early. (5) The close proximity of the nerve trunks below the knee must be remembered. I consider it quite justifiable to resect a portion of one of these where a patient complains bitterly of the pain caused by a clump of plexiform dilated varices about either malleolus, and where it is doubtful if the removal of the varicose condition above will relieve this. Owing to the multiple distribution of nerves to the foot, the numbness over the area affected becomes very little noticeable. (6) The patient should rest absolutely, in bed or on the sofa, for at least three weeks. (7) Longitudinal incisions have been alone described in this account of removal of the "dangerous area" of the internal saphena, and the upper part of the external also. In removal of some dilated clump, *e.g.*, one lying over the popliteal space or one especially troublesome which lies off the parent trunks, a flap may appear indicated. Such is to be used as sparingly as possible, as the vitality of the skin, already poor, will be further impaired. (8) If the wound becomes infected, a boracic acid fomentation should be applied at once, and those sutures which need it removed.

Trendelenberg's operation.—Here about two inches of the saphena vein are resected just below the saphenous opening. This step is only indicated in those cases to which Trendelenberg's test applies. The limb having been raised and emptied of much of its blood the saphena vein is compressed and the limb lowered. If the blood can be seen to fill the empty vein immediately after the pressure is removed Trendelenberg considered it proved that in such a case there was a column of blood reaching from the right side of the heart to the foot, unsupported by valves. The precaution mentioned at p. 1024 must be remembered here. Where there is reason to suspect that the deep veins are varicose this operation should not be performed. The spine of the pubes having been identified, a line three and a half inches long is drawn from this point and an incision three inches long made in its lower half. By some a transverse incision is preferred. Some difficulty may be met in finding the vein in fat patients. The saphena having been isolated for two inches, this portion is resected between two ligatures of sterilised silk. The inner lip of the wound should be retracted upwards to allow of the upper ligature being applied as close to the femoral vein as is possible. I need not insist upon the absolute need of scrupulous asepsis here. While Trendelenberg's operation gives good results in those cases in which it is especially indicated, I prefer that to which I have given Sir W. Bennett's name. I consider that this, by removal of the "dangerous area," leaves the patient in a safer condition, that it meets the needs of a larger number of cases, and that it is more free from risk. Either operation may, if it is desired, be performed with local analgesia (vol. i. p. 652).

CHAPTER VII.

OPERATIONS ON THE FOOT.

LIGATURE OF THE DORSALIS PEDIS.—SYME'S AMPUTATION.—ROUX'S AMPUTATION.—PIROGOFF'S AMPUTATION.—SUB-ASTRAGALOID AMPUTATION.—EXCISION OF THE ANKLE.—ERASION OF THE ANKLE.—EXCISION OF BONES AND JOINTS OF THE TARSUS.—EXCISION OF ASTRAGALUS.—EXCISION OF OS CALCIS.—MORE COMPLETE TARSECTOMY FOR CARIES.—REMOVAL OF WEDGE OF BONE, AND OTHER OPERATIONS FOR INVETERATE TALIPES.—CHOPART'S AMPUTATION.—TRIPPIER'S AMPUTATION.—AMPUTATION AT METATARSO-PHALANGEAL JOINT.—AMPUTATION OF THE TOES.

LIGATURE OF THE DORSALIS PEDIS (Fig. 441).

Indications.—Very rare. (1) Wounds. (2) Together with the posterior tibial in the lower third, for hæmorrhage from punctured wounds of the sole resisting other treatment. (3) For some vascular growths of the foot.

LINE.—From the centre of the ankle-joint to the upper part of the first interosseous space.

GUIDE.—The above line and the adjacent tendons of the great and second toe.

RELATIONS :

IN FRONT.

Skin, fasciæ ; branches of saphenous veins, and of musculo-cutaneous and anterior tibial nerves.

A special deep fascia continuous with the sheaths of the adjacent tendons.

Extensor brevis (innermost tendon).

OUTSIDE.

Vein

Anterior tibial nerve.

Extensor longus digitorum.

Dorsalis pedis
artery.

INSIDE.

Vein.

Extensor longus hallucis.

BEHIND.

Astragalus ; scaphoid ; middle cuneiform.

Operation (Fig. 441).—The foot having been cleansed, an incision about an inch and a half long is made in the line of the artery, in the lower part of its course, commencing about an inch and a half below the ankle-joint. Skin and fasciæ being cut through, and any superficial veins tied with chromic gut or drawn aside, one of the long extensors is found (its sheath is not to be opened), and the strong

FIG. 441.



The dorsalis pedis (too much of the artery is shown cleaned) is seen lying between the extensor longus hallucis and digitorum, and crossed by the innermost tendon of the short extensor.

fascia given off from them opened. If the extensor brevis cross the artery at this spot it must be drawn aside. The ligature should be passed from without inwards.

SYME'S AMPUTATION.

(Figs. 442 and 443.)

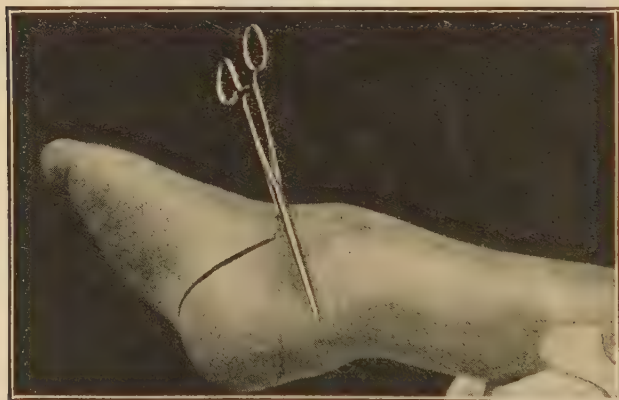
An amputation at the ankle-joint by a heel-flap, with removal of the malleoli.

Operation.—The thick skin of the heel requires careful sterilising. Hæmorrhage having been controlled, any sinuses present scraped out and disinfected, and the foot held at right angles to the leg, the surgeon, standing a little to the right, but so as easily to face the sole, marks out the points mentioned below with the index finger and thumb. He then makes, with a short, strong knife, an incision (in the case of the

left foot) from the tip of the external malleolus to a point half an inch below* the internal one, this incision not going straight across the sole as in Pirogoff's amputation, but pointing a little backwards towards the heel.† The horns of this incision are then joined by one passing straight across the joint,‡ and severing everything at once down to the ankle-joint. The foot being now strongly bent downwards, the lateral ligaments are severed, and the joint thus fully opened. The foot being slightly twisted from side to side, the tendons and soft parts on either side are carefully divided, the knife being kept closely in contact with the bones. Especial precautions must be taken on the inner side to cut the posterior tibial artery as long as possible (to ensure getting below the internal calcanean) and not to prick it afterwards.

As the operation proceeds the flap is partly pressed back by the

FIG. 442.



Application of Lynn-Thomas's forceps-tourniquet (p. 878) in Syme's or Pirogoff's amputation.

thumb, partly pulled back and so saved from damage by the knife. The chief difficulty is met with at the prominence of the heel.

The foot being still more depressed, the upper non-articular surface of the os calcis comes into view, and then the tendo Achillis. This is severed, and the heel-flap next dissected off the os calcis from above downwards, special care being taken to cut this flap as thick as possible, not to score or puncture it, but rather to peel it off the bone

* The directions usually given are to go behind this point as well as below it, but by following the above course the posterior tibial is more likely to escape section before its time, and the flap will be found sufficiently symmetrical.

† If the foot is small, and, still more, if the parts on the dorsum are damaged, the plantar incision should run straight across. On the other hand, the more prominent the heel, the more should the flap point backwards. This will facilitate turning the flap over the heel.

‡ Or with very slight convexity. If anything of a flap is made here, the operator is liable to get away from the joint and cut into the neck of the astragalus. Moreover, the parts are not well nourished, especially if sinus-riddled or undermined.

with the left thumb-nail kept in front of the knife, aided by touches of this.*

The foot having been removed, the soft parts are carefully cleared off the malleoli, and a slice of the tibia sufficiently thick to include these prominences removed. This slice should in any case, to avoid shortening, be the thinnest possible. Prof. Macleod† has recommended to remove only the malleoli, leaving the cartilage on the under surface of the tibia. I have followed his advice in my last fifteen cases—in one, a private patient of 63, where I had not the carrying out of the after-treatment, the cartilage exfoliated. In one of the others active secondary syphilis was present; in all, in spite of tuberculous sinuses in three which required repeated scraping out (Fig. 446), no exfoliation took place. In one, an elderly patient with very numerous sinuses, the result of treatment elsewhere, the operation failed and amputation through the leg was successfully performed. Prof. Macleod's advice entails less shortening of the limb and does away with the risk of infective phlebitis, which may be brought about by opening the cancellous tissue. If, on the other hand, the lower end of the tibia is diseased, it must be removed and the sawn surface gouged or treated with a sharp spoon. If the cartilage is only slightly diseased, it may be sliced off with the knife, and gouged here and there.

Tendons are now cut short, sinuses thoroughly scraped out and disinfected, and the vessels secured. Free oozing is often present in tuberculous cases, or where the periosteum has been left in the heel-flap. It is best treated by firm pressure with dry dressings, and elevation of the stump. Drainage having been provided through the cup-like heel-flap if no sinuses are conveniently placed, the sutures are inserted. I prefer some of silver wire sufficiently stout, as they last longer than silk. They should be passed at such a depth and a distance from the edge of the heel-flap to ensure their holding this up well. Where many sinuses have been present along‡ the line of the incision, it is no good uniting the wound closely.

FIG. 443.



The parts in a Syme's amputation before the heel-flap is adjusted (left side). The bones are shown above with the extensor tendons and the anterior tibial vessels, and, below, the tendo Achillis. On the inner side the flexor tendons and the plantar arteries are shown cut; on the outer side, the peronæi. This figure should be contrasted with Fig. 448.

* If, in a young subject, the epiphysis comes away in the heel-flap, it may remain there if the parts are healthy. The same course may be followed with the periosteum, if it is found loose and peels easily away. Mr. Johnson Smith, when amputating both feet for frost-bite, left the periosteum on one side. On the other no attempt was made to save it. The first stump was much larger than the other, harder, and more rounded; more like that of a Pirogoff's amputation.

† *Brit. Med. Journ.*, 1869, vol. ii. p. 239.

‡ Sinuses which have been scraped out will give good drainage if enlarged. If any puncture has been made in the heel-flap, it should be utilised for the same purpose.

While the success of a Syme's amputation depends chiefly on the care with which the heel-flap is raised, later on attention must be given from the first, and often for some weeks, to apply the bandages so as to hold the heel-flap up well and meet its tendency to glide downwards, and afterwards to hasten the moulding of it into good shape. As soon as the stump is healed, the patient, if his occupation require it, can get about on a knee-rest. In about eight weeks he will be able to bear weight on the stump.

Roux's Modification of Syme's Amputation (Figs. 444 and 445).—



FIG. 444.

Roux's amputation at the ankle-joint by an internal flap. Below is shown a foot upon which the operation has been performed. (Smith and Walsham.)

In cases where a satisfactory heel-flap cannot be obtained, an efficient substitute can be got by a large internal flap.

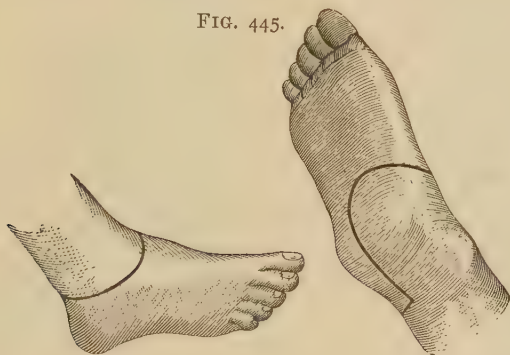
The incision is commenced at the apex of the outer malleolus, and carried half across the front of the ankle-joint, from whence it should run inwards in an oblique direction over the astragalo-scapoid joint, then pass, in a curved manner, downwards and backwards to the middle line of the sole of the foot, and, running along the under surface of the heel, ascend the posterior aspect of that part, and terminate at the outer malleolus, where it commenced. The ankle-joint should be opened at its upper and outer part, the os calcis dissected from its connections, the malleoli and a slice from the articular surface of the tibia removed, and the operation will be complete. The shape of the flap will be gathered from the appearance of a foot operated upon (Fig. 444).

Causes of Failure after Syme's Amputation.—(1) Sloughing of the heel-flap. This is nearly always due to faulty operating, to scoring

Where a diseased foot has been long on a back-splint, the skin over the tendo Achillis may be so thinned that it is advisable to make a counter-puncture here and insert a drain.

or "button-holing" the flap, or to dividing the posterior tibial high up.* (2) Persistence of sinuses and tuberculous disease. If, in spite of repeated scraping out (Fig. 446) with the aid of anæsthetics, this condition recurs inveterately and spreads along the sheaths, the limb must be amputated higher up. This will, however, be rarely called for with perseverance on the part of the surgeon to treat this condition as a kind of malignant disease. If one or two sinuses remain, and

FIG. 445.



Roux's amputation. The incisions shown from the outer and the inner side. (Stimson.)

look likely to persist, scraping out should be resorted to at once. (3) Caries in the tibia. (4) Death of the tendo Achillis.

This rare sequela occurred to me in 1890. The patient was an aged inmate of the Camberwell Infirmary. A bluish undermined patch being laid open on the back of the ankle some weeks after the amputation, the tendon was found to have died up to its junction with the calf muscles. After its removal the parts healed soundly.

PIROGOFF'S AMPUTATION.

(Figs. 447-452).

An amputation at the ankle-joint, in which the posterior part of the os calcis is retained and united to the sawn surface of the tibia.

Question of the Value of this Operation especially as compared with Syme's Amputation.—*Disadvantages*: These have been put prominently forward by Scotch surgeons. 1. The amputation is not suited for cases of disease, except of distinctly traumatic origin in young healthy subjects. 2. Occasionally the sawn os calcis fails to unite, causing either a kind of movable joint or necrosis. 3. It is said by some that the stump is more difficult to fit with an artificial foot.† The first two objections are undoubted, but I think that they are quite outweighed by the *Advantages*: 1. No dissection of the heel-flap is needed. 2. The blood-supply is less interfered with. 3. The stump

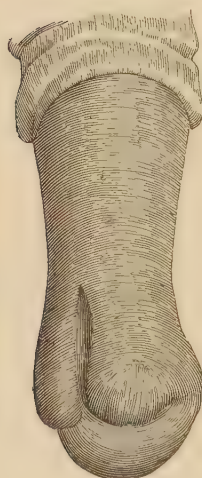
* If possible, the cut ends of the two plantar arteries should always be seen, and not the single mouth of the posterior tibial. In the former case the surgeon is certain that the main vessel is divided below the internal calcanean branch.

† Prof. Macleod thinks that the presence of the heel is here "a great drawback, and that the back of the heel, not the firm plantar pad, is what comes in contact with the ground." See the remarks p. 1034.

is firmer and more solid. 4. The stump is longer by one inch or one inch and a half, often more.* 5. The stump does not go on wasting, as is the case after a Syme's amputation.† 6. Dr. Hewson (*Amer. Journ. Med. Sci.*, 1864, pp. 121, 129) has pointed out that, in a Pirogoff's amputation the origin and insertion of the gastrocnemius being both intact, the combined movements of the knee and ankle are preserved, as in running, &c.

Operation.—The position of the patient's foot and the surgeon being as at p. 1027, an incision is made, straight across the sole, from

FIG. 446.



A Syme's stump soundly healed after scraping out of sinuses had been resorted to. The patient was sent to me by Dr. Fraser, of Romford, and had active secondary syphilis as well as extensive caries of the tarsus.

the tip of the external malleolus to a point half an inch below the internal one.‡ This incision goes right down to the bone. Its horns are then joined by a transverse cut across the front of the ankle. The lateral ligaments are now severed, care being taken to cut inside the malleoli and to divide the posterior tibial artery as long as possible—i.e., below its origin into the two plantar—and not to prick it after it is divided. With a few touches of the knife at either side of the astragalus, aided by twisting of the foot from side to side and forcible bending of it downwards, the non-articular part of the upper surface of the os calcis comes into view (Fig. 447). A groove is now cut through the fatty tissue and the periosteum, and the saw applied just in front of the tendo Achillis, obliquely downwards and forwards (Fig. 449), care being taken to bring it out through the incision in the heel. The foot being removed, the soft parts around the bones of the leg are carefully cleared to a level just above the tibial articular surface and the malleoli, where the saw is next applied, and the bones divided with a similar slight obliquity, from before backwards and downwards.

The vessels, the tibials, anterior peronæal, and perhaps one or both malleolar having been secured, the tendons cut square, the bony surfaces are placed in contact, and, if needful, drilled with a sterilised bradawl and united with wire.§

* Dr. Hewson (*loc. infra cit.*) gives the shortening after a Pirogoff's amputation as from one to two inches; that after Syme's operation as two and a half to three inches.

† The continuance of this wasting is shown by the hospital patient being for some time obliged to stuff the socket of his elephant-boot with a sock. It is not intended by this to depreciate the value of a Syme's stump. Every surgeon knows how much good, lifelong work the heel-flap is capable of, however much it shrinks, so long as it has healed.

‡ I.e., not pointing backwards.

§ If the patient is young and healthy, and if there be no tension on the piece of os calcis as this is brought forwards, this step is not absolutely needful. I would recommend it in other cases. Thus I have made use of it in a Pirogoff's amputation for inveterate infantile paralysis, with excellent results. The wire, cut short, should be well hammered down and deeply embedded.

If it is found advisable to convert the Pirogoff into a Syme, all that is needed is to divide the tendo Achillis and to dissect out the part of the os calcis, keeping the knife close to the bone.

FIG. 447.



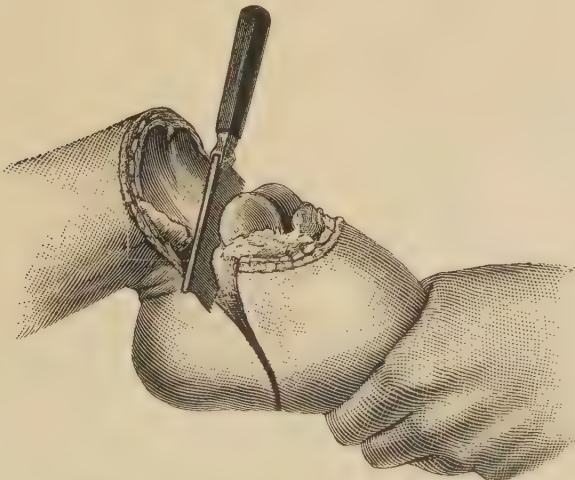
FIG. 448.



Compare with Fig. 443.

Modifications of Pirogoff's Amputation.—One of the chief of these is that introduced by **Dr. E. Watson** (*Lancet*, 1859, vol. i. p. 577). He claims—(1) That it is shorter and easier, the trouble of disarticulation being avoided. (2) That it is less likely to damage the posterior tibial artery. (3) That it does away with one of the chief

FIG. 449.



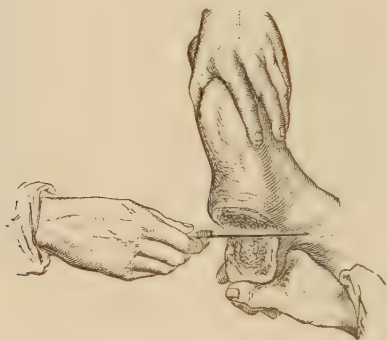
Division of the os calcis in Pirogoff's amputation.

difficulties in a Pirogoff's amputation for injury—viz., the want of purchase over the smashed parts while the os calcis is being sawn through.

Operation.—The operator, standing as before, having cut across the sole from the tip of one malleolus to the corresponding point (p. 1032) down to the bone, introduces a small Butcher's saw, or one with a narrow blade, into this wound, and saws off the posterior

part of the os calcis by carrying his section upwards and backwards. This and the heel being now retracted by an assistant (Fig. 450), the surgeon, resuming his knife, cuts upwards behind the ankle-joint between the sawn bones. The ends of the first incision are now joined by one passing between them, the skin being pulled up a little and the tendons and vessels severed down to the tibia and fibula just above the ankle-joint. Lastly, these bones are sawn through in a slanting manner by directing the saw from

FIG. 450.



Pirogoff's amputation as modified by Dr. E. Watson. (Smith and Walsham.)

before backwards and downwards.* While the bones of the leg are being sawn, the heel-flap should be held well up against the back of the leg to keep it out of the way.

Modifications by Sédillot, Gunther, and Le Fort.—In order to facilitate the fitting easily of the sawn surfaces of os calcis and tibia and to minimise any resistance to this step, Sédillot and Gunther have advised the very oblique section of the bones

FIG. 451.

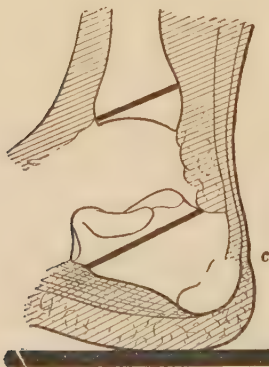
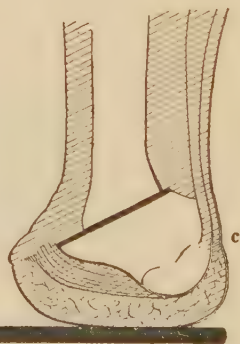


FIG. 452.



Modifications of Pirogoff's amputation by Sédillot and Gunther. (Farabeuf.)

shown in Figs. 451 and 452. **Pasquier Le Fort** goes still farther and saws through the os calcis, horizontally, parallel to its articular surface, the bones of the leg being also sawn horizontally.

* It will be noticed that the direction of the bone-section here given by Dr. Watson is contrary to that usually taught.

From my experience Pirogoff's operation gives excellent results if performed in suitable cases where the os calcis and the soft parts are both sound. One difficulty may be met with in cases of severe injury where the parts are badly smashed, and that is the want of the desired purchase while the os calcis is being sawn through. The modification of Dr. E. Watson, Fig. 450, will meet this.

Operators sometimes make another difficulty for themselves by leaving too large a portion of the os calcis. Tension is then unavoidable when the fragment is brought upwards and forwards.

SUB-ASTRAGALOID AMPUTATION (Figs. 453-455).

This operation consists—the soft parts being divided as at Fig. 453.—in opening the astragalo-scapoid joint from the dorsum, and the astragalo-calcanean, of which the interosseous ligament can only be divided by introducing the knife point from the outer side. The whole foot is then removed in one mass with the exception of the astragalus, which is left mortised in between the tibia and fibula.

This amputation has been rarely practised in England, partly because most surgeons have found that those of Syme and Pirogoff give good results, partly because the technique of the sub-astragaloid method is more complicated to remember, and also because this method requires that the soft parts of the sole should be sound as far forwards as the base of the fifth metatarsal bone. Finally, Farabeuf, a high authority, states that the stump is liable to be pulled up by the tendo Achillis taking on a firm attachment, which brings the weight of the body upon this bone and the neighbourhood of the cicatrix.

Mr. J. Hutchinson, jun., in a paper (*Brit. Med. Journ.*, Oct. 20, 1900) which, like all his writings, is lucid and instructive, strongly advocates the sub-astragaloid method, claiming the following advantages over that of Syme, of which his experience, necessarily a large one at the London Hospital, has not been satisfactory:—(1) The stump is some two inches longer; (2) it gives a broader base of support; (3) the elasticity due to the ankle movements is a marked advantage in walking; (4) the pad at the end of the stump is much thicker; (5) the arterial supply is better and runs less risk during the operation; (6) an artificial foot can be better fitted to the stump.

Operation (Figs. 453 to 455).—The following account is taken, in part, from Dr. Stimson's *Manual of Operative Surgery*, p. 113. The chief guides are the external malleolus and head of the astragalus.

FIG. 453.



The incisions in sub-astragaloid amputation. (J. Hutchinson, jun.)

The parts having been carefully sterilised, especially the thick skin about the heel, the outside of the foot is presented to the surgeon as at Fig. 453. The incision commences at the outer border of the tendo Achillis on a level of above three-quarters of an inch below the external malleolus, and is continued straight forwards below this prominence to the base of the fifth metatarsal. It is thence carried across the dorsum, slightly convex forwards, to the base of the first metatarsal. It next passes over the inner side of the foot and across the middle of the sole, again convex forwards. From the centre of the sole it is carried on to the outer border, which it gains just behind the base of the fifth metatarsal. Some operators make it join the first incision at the calcaneo-cuboid joint, others carry it onwards and backwards over the outer aspect of the foot as far as the outer tuberosity

FIG. 454.



Sub-astragaloid amputation (right foot) by large internal and plantar flap. (Farabeuf.)

FIG. 455.



Sub-astragaloid amputation (left foot) by large internal and plantar flap. (Farabeuf.)

of the os calcis, whence it curves upwards over the back of the heel to join the first at the tendo Achillis.

The incision is made throughout, down to the bones, all the tendons met with being severed at once. The soft parts are separated from the os calcis and cuboid on the outer side, and on the dorsum dissected back to the head of the astragalus. The interosseous ligament is then reached by depressing the front of the foot, passing the knife between the astragalus and scaphoid, and cutting backwards and inwards along the under surface of the former. The soft parts are next separated on the inner surface from the os calcis, injury to the vessels being avoided by keeping very close to the bone, the foot depressed, and the tendo Achillis divided. The posterior tibial nerve should be dissected out and cut short.

M. Farabeuf advises an internal and plantar flap, whose nutrition is guaranteed by a very large base. This is the flap of Roux (Figs. 444, 445).

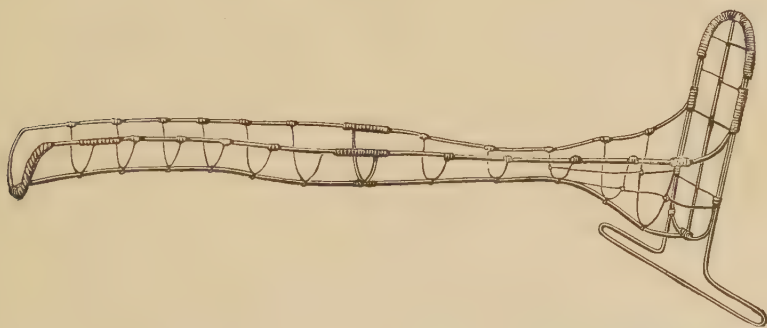
EXCISION AND ERASION OF THE ANKLE.

These may be considered together. The operation performed is usually a combined one, and is not very often called for, and the principles which should guide the surgeon in selecting one or the other have been fully given at p. 948.

Indications.—These will be considered chiefly as they relate to cases of: A. *Disease*; more briefly under the heading of B. *Injury*.

A. *Disease*.—The objections made to operations on the ankle-joint are: (1) The frequency with which the other tarsal bones are involved, the depth to which the astragalus itself is affected, and the poor vitality usually present in the patients. As regards the astragalus, the whole bone should always be removed,* and this meets, in part, another reason brought forward by Prof. Syme for preferring amputation at the ankle-joint, viz., the fact that in disease of the astragalus the joint between it and the os calcis is often involved. (2) The

FIG. 456.



Mac Cormac's splint for excision of the ankle. The shape can be modified by bending the wire, and the limb immobilised by plaster of Paris. (Mac Cormac.)

difficulty of free exposure of the parts to be dealt with. With the advantages of modern surgery this objection has lost some of its weight. (3) Amputation at the ankle-joint affords a better chance of radical cure, and also a most excellent stump. This may be imperilled by previous operations on the ankle-joint. It is only in patients with good reparative power, with disease limited to the ankle-joint and the astragalus, and of traumatic origin, *e.g.*, following a sprain, with no evidence of other tuberculous disease or syphilis, that operations on the ankle-joint are to be preferred to amputation. (4) The difficulty of securing a splint which will combine (*a*) sufficient rest, and (*b*) sufficient exposure for the needful dressings. These will be met by

* Mr. Holmes, whose experience of this operation was a large one, advised (*Brit. Med. Journ.*, 1878, vol. ii. p. 875) that the whole of the astragalus should always be removed, for these reasons—(1) As it is often softened to a considerable depth, mere removal of its articular surface will often leave disease behind; (2) in patients of poor vitality the violence done by the saw may prove the starting-point of renewed caries; (3) the bones of the leg unite sufficiently firmly to the exposed cartilaginous surfaces of the os calcis and scaphoid; (4) the shortening is not appreciably increased; (5) the difficulty of the operation is lessened.

a splint on the lines of the one shown in Fig. 456, which can be cut away at spots desired, and admits of easy sterilisation. A far simpler method is the anterior flat bar of malleable iron moulded to the dorsum of the foot and front of leg and knee-joint, covered with india-rubber, supplied with hooks for suspension, and secured by plaster of Paris. This gives admirable access, and saves any pressure on the heel. The fitting of this splint, which can be done on the sound limb, requires the careful attention of the surgeon himself beforehand, especially as to the angle over the instep by which the foot is kept in right position. Another method is that with plaster of Paris and windows (p. 1013). When the patient can get up he can use a leg-rest for some months. In those cases where, in addition to a large cavity to fill up, any tendency to œdema exists, a back and two side-splints—all being interrupted—may be preferable for the first week or ten days. The side-splints should be boiled after removal.

B. Injury.—In a young, healthy patient, where the vessels and nerves are mainly intact, where the mischief is limited to the ends of the bones, an attempt to save the limb by excision, partial or complete, is abundantly justified. The steps given at p. 1012 for the antiseptic treatment of compound fractures should be carefully attended to, as to the preservation of periosteum, the due providing of drainage, &c.

As to gunshot injuries, Dr. Otis (*Med. and Surg. Hist. of the War of the Rebellion*, part iii. p. 610) thought that "the substitution of excision of the ankle-joint for amputation effected no saving of life," formal excisions being rarely successful. The experience in later wars appears to be similar. Mr. Makins, C.B. (*Surgical Experiences in South Africa*, 1899-1900, p. 239) writes: "The ankle-joint maintained the undesirable character which it has always held as a subject for gunshot injuries. This is entirely a question of sepsis, and in great measure depends on the fact that the foot, as enclosed in a boot, is invested with skin particularly difficult to thoroughly cleanse; while the socks are an additional source of infection before the patients come under proper treatment. Of seven cases of suppurating ankle-joint of which I have notes, only two retained the foot, and one of these after a very dangerous illness."

Operation.—The necessary exposure may be secured either by two lateral incisions or by a transverse one, dividing the tendons in front, some of which are sutured afterwards. Of these the first is preferable, theoretically, owing to the smaller injury inflicted upon the soft parts. For myself, considering that a stable and sound foot is the first desideratum, and that in most hands a transverse incision, prolonged laterally as freely as is needful, gives the best exposure, and thus facilitates the eradication of all the diseased parts, which is so essential in dealing with tuberculous disease (p. 953, and Vol. I. p. 717), I have generally employed this method. If the suturing of the chief tendons is not successful—and this is a matter of difficulty with the usually small tendons—the subsequent stiffness of the toes is partly made up for by the mobility gained, in young subjects, at the medio-tarsal joint.

Lateral Incisions.—There are numerous modifications of these, but the chief point to remember is to make them freely from a point about two inches above the malleoli to one about the centre of the lateral aspects of the foot. The parts having been carefully sterilised, and an Esmarch's bandage applied, the foot is laid upon its inner side, and firmly supported by a sand pillow. A slightly angular incision is then made from a point two inches above the external malleolus behind

this prominence to one within an inch of the base of the fifth metatarsal. The external saphena vein is drawn aside or secured between two ligatures. The two peronæi tendons are carefully preserved. The wound being protected with sterile gauze, the foot is turned over and a similar angular incision is made on the inner side forwards and downwards as far as the projection of the internal cuneiform. In the centre of the incisions the operator should work down to the capsule of the joint; the ends are made free in order to give room, and also to admit of identification and displacement of the tendons. Thus the peronei on the outer, and the tibialis posticus and flexor longus digitorum on the inner side, must be carefully but sufficiently displaced from their connection with the fibula and tibia, or difficulty will be met with in adequately displacing the foot inwards or outwards. The capsule being identified, by means of a periosteal elevator the structures in front of the joint, tendons, vessels and nerves are raised *en masse* by pushing inwards and outwards from the lateral incisions and up and down as well. As much of the anterior part of the capsule as possible is then snipped away in one piece. The next step is removal of the astragalus. The joint between it and the scaphoid is first opened, and its connections with the os calcis taken next. By alternate eversion and inversion of the foot the lateral ligaments are divided, with the help of an elevator and sequestrum-forceps the astragalus is raised and drawn in different directions as the ligamentous fibres are divided with strong blunt-pointed curved scissors. The interosseous ligament is next severed; if disease be present here it must be thoroughly treated with a gouge. The difficult removal of the astragalus must be effected gradually, and without any needless bruising of the adjacent bony and cartilaginous surfaces. The presence of the flexor longus hallucis, posteriorly, must be remembered. The articular surfaces of the tibia and fibula are next scrutinised, by thrusting them through one of the lateral incisions. If they appear healthy the cartilage should be well rubbed with sterile gauze to ensure the removal of any tuberculous material. Any disease present must be removed by shaving off the cartilages, or by a gouge. Removal of either malleolus, even sub-periosteally, and in a young subject, is likely to interfere with the after-stability of the foot. Free access having been thus attained, any remnants of the synovial membrane at the back, and postero-lateral aspects of the joint are removed, and sterilised iodoform or emulsion of iodoform and glycerine (10 per cent.) applied to the cavity left. As this must in any case be a considerable one, I recommend that the needful drainage be secured by only suturing the upper extremities of the incisions, and slinging the foot for the first few days laterally, so that one of the incisions is kept facing downwards. After the deeper dressings have been secured by a few figure-of-8 turns the bandage should be carried firmly, beginning at the roots of the toes (this area having been sterilised) from below upwards, so as to prevent any œdema of the foot. As the only arteries cut are small ones, branches of the peroneal and malleolar, the Esmarch's bandage need not be removed until the dressings are *in situ*.

To secure a good result much care is needed afterwards to meet the tendency to displacement, which is two-fold: (a) pointing of the

foot downwards; (b) a lateral displacement. While here, as after other erosions, it is not always needful to disturb the deepest dressings, it is well to re-apply the bandage at short intervals to promote early consolidation of the deeper parts of the wound, and aid in the obliteration of any infective material. After three weeks, if the wound be healed, active and passive movements may be gently begun. No weight is to be borne on the foot for two months. A boot with lateral supports will be required for some time.

A. Transverse Incision.—After the full account given above it is needless to go into details here. In my opinion this method is especially indicated in doubtful cases, where the surgeon has the probability of amputation being required strongly before him, it being now very easy to proceed to removal of the foot by Prof. Syme's method.

The parts having been sterilised and rendered evascular as before, a transverse incision between the malleoli is made down to the tendons. Before these are severed guiding sutures of sterilised silk are placed in the tibialis anticus, extensor proprius hallucis and digitorum, and the anterior tibial nerve. All the structures in front of the joint are then severed, the joint opened, and the operation completed on the lines already given. It is always well to remove the astragalus, in order to secure better access to the diseased structures.

G. A. Wright, of Manchester, who gave such a healthy impetus to erosion of joints, thus describes a case operated on as long ago as 1882 (*Diseases of Children*, Ashby and Wright, p. 633).

The child was 8 years old. The joint was opened by a transverse incision across the front of the joint, dividing all the extensors, &c.; tuberculous synovitis existed with subchondral caries, all the diseased tissue, as well as the loosened cartilage were removed as far as possible. The tendons were stitched together with catgut and the wound closed. No attempt was made to unite the nerve; the anterior tibial artery was twisted. The wound was very slow in healing, but three years later the child's condition was as follows: "Foot sound and well, but the toes are somewhat pointed, and he 'throws' the foot in walking. He gets about well with a boot and without any support. A good deal of new bone-formation about line of incision, but some mobility."

Those interested in erosion of this joint should refer to a paper by Mr. W. A. Lane (*Clin. Soc. Trans.*, vol. xxvii. p. 15), in which a very free extension of the transverse incision is advocated; and one by Mr. Clutton (*Trans. Med. Chir. Soc.*, vol. lxxvii. p. 101), in which four vertical incisions are made, one in front and one behind each malleolus, and the tendons and ligaments alike avoided. The disease is removed by the sharp spoon and irrigation, aided by the finger. As stated by Mr. Clutton, an exactly similar method was described by Bruns (*Münch. Med. Woch.*, 1891.)

EXCISION OF BONES AND JOINTS OF THE TARSUS.

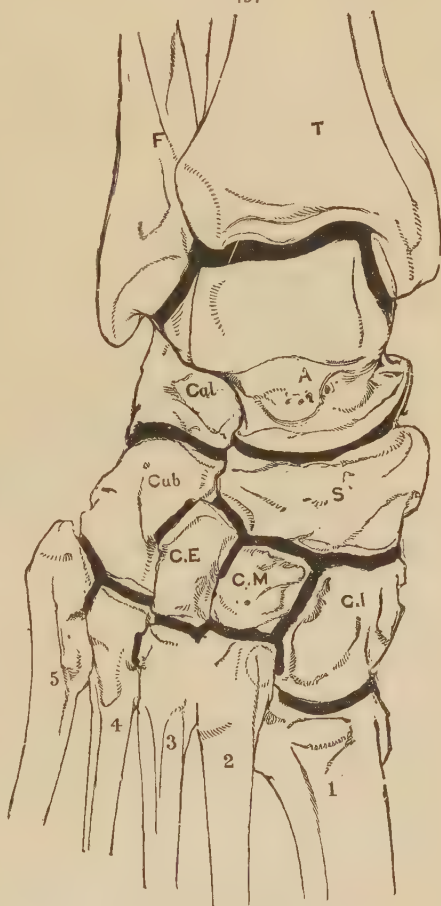
Before considering these separately, I would invite attention to the following practical points:

i. Those cases are the least hopeful in which there is no history of injury, in which there is evidence of a tuberculous constitution, or

perhaps of disease dating to an exanthem and coupled with the above constitution; cases in which the patient is wan and sickly with long-lasting pain and sleeplessness; those in which the parts are much swollen, dusky red, and glossy, with sinuses numerous or excavated, all points denoting a disease that is not limited to one joint or to few bones. ii. Mere laying open, and, still more, injection, of sinuses where there is disease of the tarsus is absolutely useless in most cases. iii. When a patient is under care for caries of the foot, his lungs should always be carefully examined before operative treatment is undertaken. iv. When the amount of disease present is being estimated, it must be remembered that patients, especially children, will often use their feet with much freedom, limping, even bearing their weight on their toes with the aid of a crutch, though all the time extensive disease is present. v. That, before an operation, the parts should always be rendered absolutely evascular by the use of Esmarch's bandages, and that thus the limit of the disease should be defined as accurately as possible. vi. Subperiosteal excision is in my opinion not advisable in tuberculous cases. It is here a step full of risk and does not offer any sufficiently compensatory advantages. vii. Strict antiseptic precautions should be made use of wherever this is possible, because — (a) Prolonged suppuration will exhaust a patient whose powers are already sufficiently handicapped by disease and operation;

(b) Suppuration will cause destruction of the periosteum, and thus fresh caries and necrosis; (c) Interference with inflamed bones may, if infection result, easily cause osteo-myelitis and pyæmia. viii. When the question arises between excision and amputation, if the powers of repair have been duly considered, the question of time and the rank of life should also be remembered. Thus, after an extensive excision, six months will probably be required before the foot can be used, but only three months after an amputation. The time in the first case may after all be wasted, a point of much importance,

FIG. 457.



To show the arrangement of the tarsal synovial membranes. (Mac Cormac.)

when the question of schooling, learning a trade, &c., have to be considered. ix. No use of a foot can be permitted after an operation till firm consolidation is obtained. x. If tuberculous mischief persist after an operation, the sharp spoon must be freely used, together with laying open sinuses, snipping away of undermined skin, &c. If all carious bone has been removed, the above steps may be repeated here, as in the knee, with ultimate success, if good general health be maintained.

EXCISION OF THE ASTRAGALUS.

Indications.—These will be for *A. Disease*, *B. Injury*.

A. Disease.—(1) Caries of the bone, especially when comparatively recent and of traumatic origin in a young and healthy patient, and when the disease is found to be limited to the upper surface. (2) In disease of the astragalo-calcaneal joint, where it is thought, from the position of the sinuses, &c., to be more advisable to expose this joint by removing the astragalus than the os calcis. (3) Talipes; in inveterate resistant cases (p. 1049).

B. Injury.—(1) Primarily. (*a*) In simple dislocation of the astragalus not reducible with the aid of anæsthetics and tenotomy of the tendo-Achillis and the tibials or extensors, if it seem likely that the skin will slough. (*b*) In compound dislocation of the astragalus when the bone is too far displaced or comminuted to admit of replacement, and when the condition of the soft parts, vessels, and tendons does not call for amputation. (2) Secondly, when the foot is useless and painful. In these cases, especially, strict antiseptic precautions must be taken and free drainage provided.

Operation.—This may be performed by two lateral or a transverse incision, with subsequent suture of the tendons, as already described (p. 1038). Another mode of access is given at p. 1049. But in tuberculous cases, especially where amputation may be found needful, I prefer the freest exposure. In some cases where a sequestrum is found on the upper surface, the removal of this and the use of the gouge is all that is required. More usually the bone needs removal and its articulation with the scaphoid and the os calcis requires attention. The necessary steps and the after-treatment have been fully described at p. 1039.

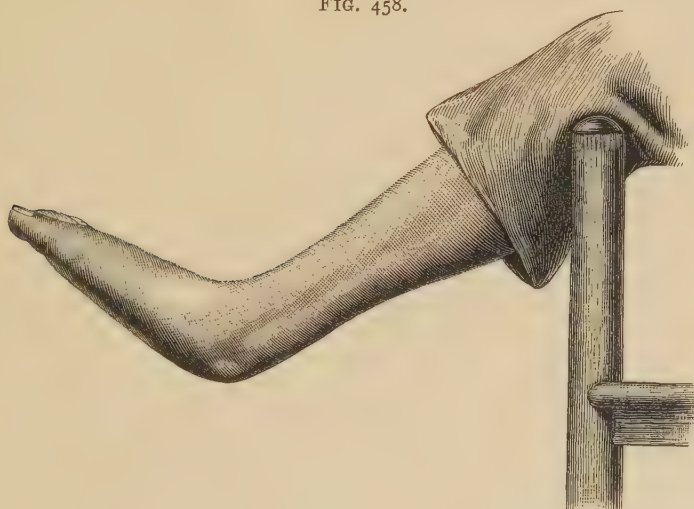
EXCISION OF THE OS CALCIS.

Practical Remarks.—Disease here is not very infrequent, and often remains limited to this bone for a long time. It may commence in one of three sites—viz., (*a*) the posterior epiphysis, which, not appearing until the tenth year, does not unite till between the fifteenth and nineteenth years; (*b*) the body of the bone; (*c*) the calcaneo-astragaloid joint, *de novo*, or as an extension from the astragalus. The diagnosis of primary disease in this joint is often difficult; thus the swelling and position of the sinuses recall disease of the ankle-joint. The pain is usually greater than in ordinary disease of the os calcis itself, and the foot is sooner disabled. With an anæsthetic, the ankle-joint is found free, and probes introduced by sinuses may pass towards

the level of the upper surface of the os calcis (known by the tubercle for the extensor brevis).

Operation.—The parts having been sterilised and rendered evascular, and the foot firmly supported on its inner side at the edge of the table, an incision* is made with a strong-backed scalpel, commencing at the inner edge of the tendo Achillis, and passing along the upper border of the os calcis (*vide supra*) at the outer border of the foot as far as the calcaneo-cuboid joint, which lies midway between the outer malleolus and the fifth metatarsal bone. This incision should go down at once upon the bone, so that the tendon should be felt to snap as the incision is commenced. Another incision is then to be drawn vertically across the sole, commencing near the anterior end of the

FIG. 458.



Foot two years after removal of os calcis in a child. The foot is flat but very serviceable. As will be seen from the state of the calf, the tendo Achillis has taken on a fresh attachment in the detached periosteum, and has been well employed.

first, and terminating just short of the inner surface of the os calcis, beyond which it should not extend for fear of wounding the posterior tibial vessels. The bone being now exposed by throwing back the flap, the calcaneo-cuboid joint is first found and opened. The peronei must be dissected out,† and drawn aside with a blunt hook.

* The above incision is taken from Mr. Holmes' article (*Syst. of Surg.*, vol. iii. p. 771). A still better one is that advised by Farabeuf (*Man. Opér.*, p. 759):—A horseshoe-shaped incision is made round the heel, beginning at the calcaneo-cuboid joint, dividing the tendo Achillis, and ending on the inner aspect of the foot, external to the posterior tibial vessels and nerves. To this incision a short vertical one is added, running up along the outer side of the tendo Achillis. By turning aside the flaps thus marked out the bone is most thoroughly exposed.

† Mr. Holmes (*loc. supra cit.*) says that he has always divided these without ill effect. Care must be taken in drawing them aside, for, if this is done too vigorously, one may slough, as happened to me in one of my cases.

The astragalo-calcanean joint is next attacked; and the close connection between the bones at this point constitutes the principal difficulty of the operation, unless the ligaments have been destroyed by disease. This difficulty can best be met by grasping the bone firmly with lion-forceps, and wrenching it backwards and outwards, aided by levering movements of an elevator, and a knife-point kept very close to the bone. Especial care must be taken on the inner side to avoid the vessels. The bone being removed, the gap is lightly plugged with gauze, and the dressings applied before the Esmarch's bandage is removed.

The question of preserving the periosteum has already been referred to, p. 1041. Some good cases of excisions of tarsal bones are recorded by Mr. Holmes, *Syst. of Surg.*, vol. iii. p. 769 *et seq.*; and *Surg. Treat. of Children's Dis.*, chap. xxvi.

OPERATIONS FOR MORE COMPLETE TARSECTOMY.

It is scarcely worth while to give directions for the removal of other single bones—*e.g.*, the scaphoid and cuboid—as these are rarely diseased alone, and, if this should be so, their removal is easy.

The operations of Mickulicz and of Dr. P. H. Watson will be described to meet those cases where more extensive disease is present, and where the patient's age and condition justify a trial of these severe operations instead of amputation. In the very few cases which call for these operations Watson's is, in my opinion, to be preferred, as it leaves a foot at right angles with the leg.

Operation of Mickulicz.*—The object of this operation is to procure an artificial pes equinus, and to preserve the toes and metatarsals, these being brought into a straight line with the leg, and the toes bent at a right angle, so that the patient walks on the ends of the metatarsal bones covered by the thick pads of tissue which invest them; a broader surface of support is provided than after Syme's or Pirogoff's amputations, and there is some elasticity of the foot left. I do not recommend this operation, and only introduce the account from my respect for the surgeon whose name it bears. The result is obtained at far greater cost and risk than that by a Syme's amputation, and is, in my opinion, of very doubtful superiority. It is fair to state with regard to this opinion and the result in the case which follows, a case from its nature unpromising for any operation, that Prof. Nasse and Dr. Borchardt (v. Bergmann's *Syst. of Surg.*, *Amer. Trans.*, vol. iii. p. 886) write: "The results of this operation are generally good. Of 73 cases collected by Kohladds in 1891, 56 could stand and walk well." Mr. Bland Sutton (*Lancet*, 1893, vol. ii. p. 1513) brought before the Medical Society the skeleton of a foot three years after the performance of a Mickulicz's operation. The artificial pes equinus had been produced by Sir W. Mac Cormac in a girl, aged 18, the subject of infantile paralysis. In spite of the anatomical success of the operation the foot was of little service in progression, causing the girl much pain and inconvenience, and Mr. Sutton removed the leg by amputating through the knee-joint.

Sir W. Mac Cormac's patient was aged 15, and the disease dated to a sprain of the ankle. On the lad's admission the swelling and sinuses pointed to disease of the os calcis; later on the ankle-joint became involved. Amputation being refused, Sir W. Mac Cormac operated thus: "The patient was placed in the prone position. If it be the right foot, the knife is introduced on the inner border of the foot, just in front of the scaphoid

* The account of this is taken from a paper of Sir W. Mac Cormac's (*Lancet*, May 5, 1888), four figures accompanying this. Mickulicz's paper will be found in *Langenbeck's Arch.*, 1881, Bd. xxvi. S. 191.

tubercle, and a transverse incision, extending to the bone, is made across the sole to a point a little behind the tuberosity of the fifth metatarsal. On the left foot the direction of this incision will be reversed. From the inner and outer extremities of the wound incisions are prolonged upwards and backwards over the corresponding malleolus, and their extremities united by a transverse cut across the back of the leg, down to the bone, at the level at which it is to be sawn, usually immediately above the joint surface of the tibia. In cases where a larger removal of the tibia and fibula is required, the lateral incisions must be more oblique, and the posterior transverse cut made at a higher level. The ankle-joint is now opened from behind, the disarticulation completed, and, after flexing the foot, the soft parts are carefully separated in front until the medio-tarsal joint is reached, through which disarticulation is effected as in Chopart's amputation. The heel portion of the foot, consisting of the astragalus, calcis, and the soft parts covering them, is thus removed. The articular surfaces of the tibia and fibula, with the malleoli, are now sawn off, as well as those of the cuboid and scaphoid. The anterior portion of the foot remains connected with a bridge of soft parts. The blood-supply appears to be ample, for almost directly after the operation blood issued freely from the distal ends of the divided plantar arteries. All hæmorrhage having been arrested, the foot was brought into a straight line with the leg, and the cut surfaces of the bone were sutured together with kangaroo-tendon. The attempt to discover and unite the divided ends of the posterior tibial nerve failed, on account of the sodden condition of the soft parts. Suitable dressings and a plaster-of-Paris splint were applied, the toes being brought into a position of complete dorsal flexion."

The boy made an excellent recovery. Firm bony union took place. In about a month sensibility began to return in the sole, and gradually became more complete. The toes were mobile.*

Operation of Watson.—This is adapted to cases where the medio-tarsal articulation is involved, the importance of which, from the number of bones and the complicated synovial membrane, is well known (p. 1041). In other words, the disease should be situated between the bases of the metatarsal bones in front and the os calcis and the astragalus behind. The parts being rendered evascular, incisions three to four inches long are made, on the outer side from the centre of the os calcis to the middle of the fifth metatarsal bone, and on the inner from the neck of the astragalus to the middle of the first metatarsal. The soft parts are carefully dissected off from the dorsal and plantar aspects of the foot by means of these incisions, the left thumb being kept between the point of the knife and the soft parts. With a curved probe-pointed bistoury the joints between the astragalus and scaphoid, and os calcis and cuboid, are opened up, and, a saw being passed between the plantar soft parts and the metatarsal bones, these are cut through from below upwards. The diseased bones being removed, the wound is firmly plugged and pressure applied with gauze pads and bandages before the tourniquet is removed. That this operation, though little known, is an excellent one in Dr. Watson's hands, is shown by the fact that five out of his six cases did well. It must be remembered that it is an operation in the dark, and one that may involve a good deal of damage to soft parts, owing to the amount of disease which has to be removed by somewhat limited incisions.

REMOVAL OF TARSAL BONES FOR INVETERATE TALIPES.

Indications.—Cases which deserve the above epithet of inveterate, in which tenotomy, syndesmotomy, and forcible manipulation† have

* The patient was shown to the Medical Society more than a year after the operation. "He walked up and down the room, both with and without his boot, with great ease and evident satisfaction to himself. The union is quite solid, and he now attends to his daily work without any inconvenience."

† Especially by the aid of Thomas's wrench. An excellent account of the use of this—in fact, one of the very best descriptions of the treatment of talipes in the English

been thoroughly tried; cases in which there is evidently confirmed alteration in the shape of the bones—*e.g.*, in talipes equino-varus—such rigidity that the position of the foot cannot be possibly altered, the astragalus projecting outwards on the dorsum, and the scaphoid so displaced that it almost touches the internal malleolus; where the patient walks on the outer border of his foot, and large bursæ have formed over the cuboid; and where the patient is prevented from earning his livelihood. Finally, the surgeon must feel assured as to his power of conducting the case aseptically.

I am of opinion that the following **operations** will enable the surgeon to deal with cases of resistant or inveterate talipes met with nowadays, and further that these methods are best adapted to the largest number of operators, a point which has been insisted upon several times in this book. In order of selection they are: (i.) **Division of tendons and other existing structures by a flap incision on the inner side of the foot** (Fig. 459); (ii.) **Removal of the astragalus**; (iii.) **Cuneiform tarsectomy**. Before they are described I would impress most strongly upon my younger readers the cardinal importance of the following: (1) Relapses will follow after any operation, however complete and severe at the time, unless the patient is kept under observation sufficiently long for the surgeon to feel certain that the case is cured. (2) Relapses depend either upon the patient being too soon removed from supervision, or upon the surgeon saying prematurely that the cure is complete. I have generally laid down the rule to the parents that in addition to regular supervision by the surgeon, daily attention will be required on their part until the child is old enough to realise the right position of the foot, and sensible enough to take a due share in maintaining it. (3) No cure is complete until the patient has been walking, under skilled observation at intervals, for a sufficient time. It is quite impossible to lay down any law or limit here. For cases before puberty many years are required, for adults at least one year is needed. The more severe the case the more care is required for the surgeon to be absolutely certain that, when walking is allowed, the body-weight falls on the foot in the right position, and not unduly on the outer side, perpetuating, if even in the slightest degree, the varus. In no case is there more need of the surgeon, before he undertakes these troublesome cases, ensuring that the parents realise their responsibility in the after-treatment. This point is frequently overlooked. (4) While there is no routine method of operation in these cases, the surgeon will, of course, secure the best results from that operation with which he is most familiar.

Division of tendons and other resisting structures by a flap-incision on the inner side of the foot (Fig. 459).—Since I became acquainted with this method I have used it largely, and have had every reason to be increasingly satisfied with it. While the incision is uncomplicated it gives sufficient access. It is very easy to combine the operation with the use of the wrench. In bilateral talipes equino-varus both feet

language—is given by Mr. R. Jones, of Liverpool, and Dr. Ridlon, of Chicago, in the *Medical Annual* for 1896, p. 448. Another very helpful account of talipes is that given by Mr. Tubby in his work on Orthopaedic Surgery.

can be dealt with at one operation. I shall first describe it in the words of its introducer, Dr. A. F. Jonas (*Ann. of Surg.*, 1899, p. 449), who had employed it in twenty-five cases with satisfactory results: "An incision is made beginning slightly below the margin of the plantar fascia on the inner side of the foot, at a point on a line directly below and anterior to the internal malleolus, extending forwards and upwards to a point on the first metatarsal bone, and nearly to the metatarso-phalangeal articulation. A second incision is made beginning at a point over the astragalo-scapoid articulation, extending forwards and slightly downwards, joining the first incision near the metatarso-phalangeal joint, forming a V. The incisions are made deep so as to include the subcutaneous tissue and fat. The flap is dissected backward to the points first indicated. We have now exposed all the shortened soft structures. We first sever diagonally the inner fasciculus of the plantar fascia. The diagonal division of the plantar fascia is done so that after correction there shall not be left a defect between the divided ends, but that the points of the incised fascia still come

FIG. 459.



in contact, thereby lessening the tendency to contraction of this structure when repair is complete. The remaining structures are now divided successively as directed by Phelps, until the astragalo-scapoid capsule is reached. Instead of dividing this, we make another incision on the outer side of the foot, over the head of the astragalus, pushing aside the tendons and soft structures and exposing the neck of that bone, and then cut through the neck with a chisel. We can now push the forward part of the foot outward without separating the astragalo-scapoid articulation which nearly always occurs in the typical Phelps' operation." After bleeding has been arrested the wounds are closed and the limb put up in plaster of Paris.

I have sometimes found it well to make a vertical flap (not encroaching upon the sole) instead of the more horizontal one advocated by Dr. Jonas (Fig. 459). The internal saphenous vein can be drawn out of the way. The tibialis anticus tendon is easily found above. As no Esmarch's bandage is required, the pulsation of the posterior tibial artery is a guide in the division, with blunt-pointed scissors, of the tibialis posticus and flexor longus digitorum. Believing that in cases at all advanced the shortened astragalo-scapoid capsule is an important element in keeping up the resistance, I have divided this, the foot being everted and

abducted. This step while it has not appeared to weaken the foot at all afterwards has enabled me to dispense with the second incision and osteotomy of the neck of the astragalus recommended above. In cases where the skin, in addition to the deeper parts, is much shortened, I have not found it possible to secure complete suturing and primary union of the wound, whichever incision is employed. With reference to this point it will be remembered that here, as after any operation for talipes, the foot must be put up, whether in a short Dupuytren's splint, or in plaster of Paris, in the over-corrected, everted position.

Phelps' Operation by Open Incision.*—The foot having been cleansed and rendered evascular is placed on its outer side, and a line is drawn from the tip of the inner malleolus to the tuberosity of the scaphoid. From the centre of this line an incision is made outwards across the inner third of the sole,† down to the neck of the astragalus on its inner side. Through this wound the plantar fascia, abductor hallucis, tibiales posticus and anticus, the long flexors, together with the internal lateral and calcaneo-scaphoid ligaments, are divided. If possible, the internal plantar vessels and nerve are spared. Great force is then used to rupture the deeper ligaments and over-correct the foot. Phelps also divides the tendo Achillis at the same time; others prefer to leave this step till a later occasion. The wound, partly sutured, is put up without drainage, and must heal partly under blood-clot, partly by granulation. The foot is maintained in the over-corrected position by plaster of Paris.

This operation has been modified in various ways in order to avoid the tendency to recurrence which results from the contraction of the scar left on the inner side of the foot.

Mr. W. A. Lane (*Lancet*, Aug. 19, 1893) puts on a large skin graft on the second day, in order to promote more rapid healing. Mr. T. H. Kellock (*Lancet*, March 30, 1895) partially fills the gap by means of a skin flap from the dorsum of the foot. Dr. W. Gardner, of Melbourne, quoted by Tabby (*Orthopædic Surg.*, p. 435), inserts a wedge of decalcified bone between the scaphoid and astragalus, "to which bones it is wired, and by this the lengthening of the inner side is maintained until the plate is replaced by fibrous tissue."

Lane's † Complete Subcutaneous Section.—Mr. W. A. Lane, believing that the later results of Phelps' operation are very unsatisfactory owing to the "absolute loss of continuity of all the soft parts in the sole of the foot," advises the following method (*Lancet*, vol. ii. 1893, p. 432): "An india-rubber bandage is applied above the knee to control the circulation, so as to prevent the free bleeding that would otherwise occur, and then, by means of a strong, long-bladed, sharp-pointed tenotomy-knife, everything beneath the skin that opposes the placing of the foot in a position of moderate abduction upon the astragalus is divided. This includes the several divisions of the plantar fascia, part of the internal lateral and annular ligaments, the superior internal calcaneo-scaphoid, the inferior calcaneo-scaphoid and the long and short plantar ligaments, together with the tibialis anticus and all the tendons, vessels, and nerves in the sole of the foot. This cannot be done satisfactorily through a single puncture; but I do not hesitate to make any number of punctures, only taking care that the knife is entered in such a direction that the forcible fixation of the foot in a position of abduction does not cause the wound made by it to gape. This is a matter of considerable importance, since it is frequently necessary to sew up the apertures which are made by the knife, otherwise arterial blood spurts through them on removing the tourniquet. By spending some time, and by exercising a moderate amount of skill, it is possible to divide all the soft parts opposing abduction of the foot on the astragalus and to leave the skin intact, except for the punctures produced by the tenotomy-knife. After this has been done, I pass a knife between the skin and tendo Achillis and divide it. If the foot does not become square I cut all the soft parts except the peronei,

* Mr. E. Owen strongly advocated this operation (*Med.-Chir. Trans.*, vol. lxxvi. p. 89).

† Phelps originally made his incision two-thirds across the sole, but modified it owing to the tender scar which was liable to result.

‡ A somewhat similar operation is given by Buchanan (*Brit. Med. Journ.*, Oct. 27, 1888).

carefully dividing the posterior ligament of the ankle-joint, which often opposes free movement of this articulation."

With regard to the above operations, I am of opinion that cases severe enough to require them are best met by cuneiform tarsectomy (*vide infra*).

Removal of Astragalus (Lund., *Brit. Med. Journ.*, Oct. 19, 1872).—This is indicated in cases of equino-varus where the astragalus is the chief cause of the deformity, where the equinus is more marked than the varus, and especially in paralytic talipes equinus. The resisting tendons, fasciæ and ligaments must be divided as well and the muscle thoroughly employed. Even after this step has been taken in equino-varus and the astragalus has been removed, it may be needful in order to secure the needful over-correction to remove the scaphoid, cuboid and anterior part of the os calcis. The late Mr. Walsham advised partial division of the external malleolus with bone-forceps and then carrying the foot outwards, bending the malleolus backwards and outwards also. In his words, "When once a bone-operation has been embarked on, it is no use stopping short till sufficient bone has been cleared away to permit of the rectification of the foot. No more should, of course, be removed than is necessary, but to take away too little is to my mind much the graver fault." But before removing other bones than the astragalus the operator should be certain that the resistance of the soft structures it entirely overcome. Several incisions have been employed.* The following will suffice. The projection of the astragalus renders its removal easier than would otherwise be the case. A longitudinal incision about two inches long and gently curved, is made over the most projecting part of the head of the astragalus from the external malleolus downwards and inwards, between the outermost tendon of the extensor longus digitorum and the peroneus tertius. The soft parts on either side of the incision having been raised with an elevator, the ankle- and astragalo-scaphoid joints are opened, and the bone is loosened in its bed with an elevator while its ligamentous attachments are divided with blunt-pointed scissors. This is facilitated by drawing the bone in different directions with lion-forceps. The chief difficulties met with are: (1) the closeness with which the bone occupies its socket, and the consequent readiness with which, if a sharp instrument be used to lever out the astragalus, slices of cartilage are detached from the scaphoid or malleoli; (2) division of the ligaments, especially the interosseous and the internal lateral.

In those advanced cases where it is doubtful if removal of the astragalus will suffice, I generally prefer to remove a wedge at once, as involving less disturbance of the parts than two operations, and as being certain. Mr. Walsham, however, prefers beginning with removal of the astragalus.

Cuneiform Tarsectomy.—This operation is especially indicated in those inveterate or resistant cases of talipes where great prominence of the astragalus is not the prominent feature, where the fixity is too great to be overcome by the removal of one bone, or where this step has been used and failed. Personally, I prefer this operation in every

* G. A. Wright (*Diseases of Children*, with Dr. Ashby, p. 687) advises an incision over the ankle-joint, from the tibialis posticus to the anticus, and another incision at right angles to the first along the inner side of the tibialis anticus.

case which is beyond the remedy of judiciously employed "wrenching," and the operation described at p. 1046. When I say in every case, I should like to make one reservation. I am referring to the bulk of cases which come before a hospital surgeon. Where these can afford time and expense, where the parents have the good sense to be patient over the time which is required to secure good results—in such cases milder methods will often suffice. But with the great majority of hospital cases it is not so. Time for schooling, apprenticing, and so forth, is urgently needed, perhaps much has been already lost. Even moderately expensive apparatus is difficult of attainment; intelligence and patience on the part of the parents or patient are, very often, not forthcoming; the regular attendance which is absolutely needful is broken off or interrupted, thus causing the inevitable relapses so well known to every surgeon of experience. Looking upon treatment here as mainly a question of time, not only to fit the patient to play his part in life's battle, but because the longer the deformity is left the worse is the habit of walking acquired, I generally resort to tarsectomy in patients as young as ten or eleven, and very occasionally even younger. I admit the foot is flat and shortened, and in some cases stiff, though this last is due to imperfect after-treatment and insufficient manipulation and active and passive exercise of the foot. *Though flat and shortened, the foot is square, without any tendency to inversion, after a well-managed tarsectomy.* This, I maintain, is the chief object before us in these resistant cases of talipes, and, as it is attained most speedily and certainly by tarsectomy, I recommend this operation strongly in poorer patients who can least afford to lose time.

With regard to the matter of **age**, I would refer my readers to papers by the late Mr. Walsham (*Brit. Med. Journ.*, 1893, vol. i. p. 339) and Mr. Ewens, Surgeon to the Bristol Children's Hospital (*ibid.*, 1891, vol. ii. p. 843). Both these surgeons advocate resort to removal of bone at an earlier age than is usually allowed; both consider such operative steps justifiable, in special cases, in children only three years old. In Mr. Walsham's words: "I have not done a bone operation on these patients at a younger age than two or three years, but at that tender age I have found that, even after removal of the astragalus, the foot in some instances could not be got into a satisfactory position until further portions of the bones had been excised." Where, with the advantages of a well-ordered special department, skilled assistants and nurses, and ample experience, Mr. Walsham found milder methods fail, other surgeons—working, perhaps, under less happy surroundings—need not fear to resort, in like occasional cases, to removal of bone.

Operation.—The parts having been rendered evascular with Esmarch's bandages, are duly resterilised and supported on a sand-bag. A T-shaped incision is then made with the horizontal limb along the outer side of the foot over the os calcis and the cuboid, and the longitudinal one at a right angle to this passing across the dorsum and ending over the scaphoid. The flaps thus marked out are turned aside. With a periosteal elevator the tendons and vessels on the dorsum are now raised *en masse*, so that sufficient room is given for the saw to pass between them and the bones. With a retractor on the outer side the peronei tendons are held out of the way, due care being taken of their sheaths to avoid the risk of sloughing. With a narrow-bladed saw, a

wedge of bone of sufficient size is then removed by two cuts, one above and one below, meeting at the scaphoid. The upper of these will pass through the os calcis to the scaphoid, the lower through the cuboid, through the joint between this and the fifth metatarsal, or through the base of this bone, according to the severity of the case. While these sections are made, a blunt dissector should be pushed under the bones very close to their plantar surfaces, so as to protect the soft parts beneath. The wedge of bone is then removed with a lion-forceps, or by levering it out with an elevator, care being taken not to damage any parts used as a fulcrum. As it is twisted out, a few attachments to the structures in the sole may require division or peeling off. If the position of the foot cannot be rectified, the gap may be widened by removing more bone either with a saw or with a chisel and mallet; it is especially towards the apex that this must be done. But before this step is taken any resistance due to the soft structures should be overcome. This is effected by prolonging the apex of the incision over the inner side of the foot and dividing the tendons, &c., by the steps given at p. 1047. When the foot can be brought into good position any tendons that have been divided are united with carbolised silk or chromic gut. Any vessels which can be seen are then secured, a drainage-tube is inserted, and the wound partly closed with sutures. Sufficient gauze dressings are then firmly bandaged on before the Esmarch's bandage is removed. The foot is put up with a back and two side splints, or on an external splint with an interruption, the knee being flexed and the limb resting on its outer side. Mr. Davy has devised a special splint to secure eversion. Morphia should be given freely at first if required. In six or eight weeks the union should be firm.

If after the operation the foot still turns in because the whole limb does so, osteotomy of the femur at about the junction of the middle and lower thirds should be performed, and the leg and lower fragment turned somewhat outwards.

Great care must be taken during the after-treatment to keep the parts aseptic. (Edema, &c., are of very likely occurrence, if, owing to an insufficient wedge being removed, much force has to be employed to correct the inversion. Occasionally complete closure of the wound is delayed by the coming away of a scale of bone; the ill-vitalised corns and bursal tissues may show some signs of sloughing. In those very severe cases, rarely met with nowadays, where this condition of the skin seriously imperils its vitality, a Pirogoff's amputation may be the wiser step.

Operative Treatment of Flat-Foot.—Numerous methods have been employed here. I am only familiar with that of Prof. Ogston (*Lancet*, 1884, vol. i. p. 152), in which the articular surfaces of the astragalo-scaphoid joint are removed, the proper position of the foot restored as far as is possible, and thus retained with ivory pegs. Sir W. Stokes's operation, in which a wedge is taken from the head and neck of the astragalus (*Brit. Med. Journ.*, Dec. 1, 1894), is the more scientific one, as in it the mediotarsal joint is, theoretically, left untouched, but in practice it is difficult to ensure this.

Ogston's Operation.—The site of the displaced astragalo-scaphoid joint having been exactly identified, the parts most carefully sterilised

and an Esmarch's bandage applied, a longitudinal incision, about two inches long, is made over the joint and deepened down to the bones. If it be preferred, the incision may be curved or a rectangular one, one over the joint and the other at right angles to it towards the dorsum, and small flaps made. The ligaments and periosteum together, having been carefully raised from the bones to the needful extent, and to this only, the articular cartilage is detached on either side with a chisel, the bevelled surface of which is turned towards the scaphoid and away from the astragalus. Two holes, half-an-inch apart, are now drilled through the scaphoid into the astragalus, towards the centre of its head. Sterilised fine ivory pegs are then driven into the holes and cut short. To get the foot into the best possible position before the joint is opened, the foot should be strongly moved or wrenched in every direction, especially in those of adduction and inversion. While all surgeons of experience are familiar with the very slight reaction that follows on forcible rectification without operation, it is another matter when a deep wound has been made. Hence the need of rigid attention to asepsis before, during, and after the operation. Wire hammered down may replace the pegs, or any retaining material may be dispensed with altogether (Openshaw, *Clin. Journ.*, Dec. 12, 1894). If needful, the rectification must be completed a week or ten days after the operation. The patient must not walk on the foot for a period of two to three months. In bilateral cases both feet should be operated on at the same time.

Prof. Ogston found that in those cases where complete restoration of the arch was impossible, great improvement followed, and that this improvement was lasting.

Here, as in all cases where a surgeon once embarks on removal of bone for aggravated deformity, he must continue until sufficient is taken away to permit of over-rectification. Otherwise relapse is certain. Thus where the valgus at the ankle is more marked than the flatness in the sole, the tibia and fibula must be divided through lateral incisions, and the deformity over-corrected. To prevent the stiffness which may follow on operations at or near to the astragalo-scaphoid joint, Trendelenberg and Hahn prefer to divide the tibia and fibula. In some cases valgus of the great toe will also require attention.

CHOPART'S AMPUTATION (Figs. 460-463).

In this medio-tarsal amputation only the astragalus and the os calcis are retained, disarticulation being effected through the joints between the above bones and the scaphoid and the cuboid.

Value of the Operation.—This has been a good deal disputed. The following objections have been raised to it:

1. That the tendo Achillis, no longer counterbalanced by the extensor muscles, which have now lost their attachment, draws up the heel, tilting down the scar, which now becomes tender and irritable (Fig. 463).
2. In the normal foot the weight of the body is transmitted through the astragalus to the other bones of the tarsus and metatarsus. When, as in this amputation, these bones have been removed, the weight of the body tends to thrust forward the astragalus, no longer supported by the elastic bones in front, against the scar (Fig. 463), and thus

renders this tender and crippling. The above objections apply to the operation performed for injury or disease, the next to amputation for the latter only. 3. If the operation be made use of in caries, this disease is likely to recur in the two bones left. In answer to the first two of the above objections it may be said that this tendency to tilting upwards of the heel and downwards of the scar may be met: (a) By stitching the anterior tendons—*e.g.*, tibialis anticus, extensor proprius hallucis, and some of the tendons of the extensor communis—into the



Incisions in Chopart's amputation. (Fergusson)*.

tissues of the sole-flap with stout carbolised silk or chromic gut, so as to give them a fixed point by which they may counterbalance the tendo Achillis;† (b) by cutting the plantar flap sufficiently long, and securing firm primary union; (c) by division of the tendo Achillis. This, however, is only of fugitive value; (d) wearing a wedge-shaped pad in the boot to raise the front of the stump; (e) preserving the scaphoid, when sound, so as to retain the attachment of the tibialis posticus. "It has not been shown that this modification is of special value" (Treves).

The third objection is answered by only performing this operation for caries when the disease is limited to the front of the foot, is of distinctly traumatic origin, and occurs in a healthy patient.

Operation (Figs. 460 and 461).

—An Esmarch's bandage being applied, and the foot supported at a right angle over the edge of the table, the surgeon, standing to the right side of the foot, and so that he can easily face the sole, places (*e.g.*, on the right side) his left index and thumb immediately above the tubercle of the scaphoid and the corresponding point on the outer side—*viz.*, the calcaneo-cuboid joint, which lies

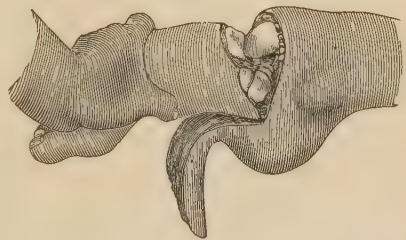


FIG. 461.

* Too much dorsal flap is shown here; the next figure shows the correct amount.

† We owe this ingenious precaution to Mr. Delegarde, of Exeter. Till it is more frequently made use of, and a larger number of cases are collected, the value of this amputation must remain somewhat undecided. I have operated on five occasions—one a severe crush, another for the results of perforating ulcer, and in three for caries of the front of the foot; in all this precaution was taken, and the stumps proved sound and useful. One I watched for four years.

midway between the external malleolus and the base of the fifth metatarsal bone. He then joins these points by a slightly curved incision crossing the tarsus, and dividing everything down to the bones. The foot being flexed upwards, a plantar flap is then marked out by an incision running from the outer extremity of the first up the outer side of the little toe, then across the sole on a line just short of the balls of the toes, and then down the inner side of the great toe to join the inner extremity of the first.* The flap thus marked out is raised with the same precautions given at p. 1057. It is then held out of the way, and the anterior half of the foot being strongly depressed, disarticulation is effected by passing the knife above the tubercle of the scaphoid between this bone and the astragalus, and then between the concavo-convex surfaces of the calcaneo-cuboid joint. In effecting this the position of the joints and the shape

FIG. 462.



Stump after Chopart's amputation.
(Fergusson.)

FIG. 463.



Stump stated by Farabeuf to be often met with after Chopart's amputation, showing its shape, the position of the bones, and the influence of the tendo Achillis.

of the astragalus must be remembered, and Mr. Skey's words borne in mind: "The joints should be opened with tact and not by force: if the knife be applied to the right surface, it will pass without effort into the articulation; if in the wrong direction, no force will effect it."

The anterior tibial and plantar arteries are then secured, and, on removal of the Esmarch's bandage, any other vessels which require it. The flap is then folded up over the bones, but without any forcible bending, which might interfere with the blood-supply. While it is held in this position, before any sutures are inserted, the extensor tendons (*vide supra*) should be carefully stitched with sufficiently stout silk into the fibrous tissues which abound in the plantar flap, care being taken, in so doing, not to puncture the external plantar vessels, but at the same time to secure a sufficient hold.

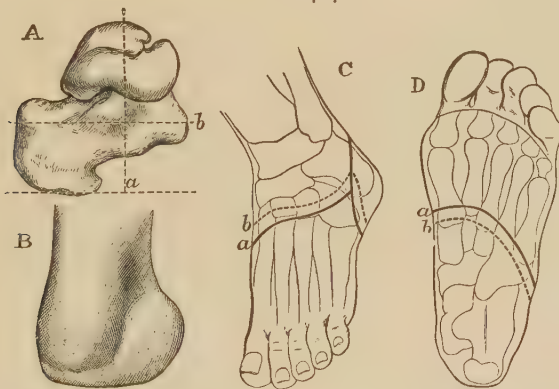
* The flap should be a full inch shorter than that in Lisfranc's operation (p. 1056), if the tissues are sound. An unduly long and large plantar flap will here, as after a Lisfranc's amputation, form an unwieldy pocket (Treves).

TRIPPIER'S AMPUTATION* (Fig. 464).

This operation was proposed by Dr. L. Trippier, of Lyons, as an improved modification of Chopart's amputation, over which it is thought to possess the following advantages: (1) The horizontal division of the os calcis on a level with the sustentaculum tali gives a large surface of support entirely free from the objections to that in Chopart's amputation (p. 1052). Mr. Wagstaffe (*Lond. Med. Record*, 1880, p. 135) considered the following to be further advantages—*e.g.*, that less plantar flap is needed, and that the operator can see the state of the os calcis, amputating higher if this bone be too much diseased. The following advantages claimed for M. Trippier's amputation over the sub-astragaloid (p. 1035) are: (i.) The limb is longer, (ii.) the section of the os calcis gives a larger and more solid basis of support. (2) By making the section of the os calcis, the tendons, especially the tendo Achillis, are better preserved.

Plantar and dorsal flaps are marked out on somewhat similar lines to the sub-astragaloid method (p. 1035) by the following incisions, the dorsal starting from the outer part of the tendo Achillis at its insertion, then passing about an inch and a quarter below the external malleolus forwards to a point about the same distance above the tuberosity of

FIG. 464.



Trippier's amputation. *a*, Section through the skin. *b*, Through the soft parts.
(T. Bryant.)

the fifth metatarsal bone; the incision then curves inwards to end at the inner side of the extensor proprius hallucis, over the tarsal end of the first metatarsal bone. From this point the plantar flap is marked out by an incision downward and forward over the inner part of the sole, about an inch in front of the base of the first metatarsal bone, and then obliquely across the bases of the metatarsals, and, lastly, backwards, so as to join the dorsal incision over the outer part of the os calcis. All the dorsal tendons are then divided along the line of the incision, and the structures in the plantar incision are cut down to the bones. A thick plantar flap is now raised until the under surface of the os calcis is exposed, and the point of the heel turned. Disarticulation, as for Chopart's amputation, is then performed. The periosteum covering the under aspect of the os calcis is now incised antero-posteriorly, and detached from the bone up to the level of the sustentaculum tali. The os calcis is next sawn through horizontally from within outwards, on a level with the same process. The projecting angles are then rounded off, and the plantar and dorsalis pedis arteries tied. As in all amputations, the nerve that will bear pressure in the flap—here the posterior tibial—should be trimmed short.

* A case of this amputation by Mr. Hayes, of Dublin, will be found in the *Brit. Med. Journ.*, 1881, vol. i, p. 303.

AMPUTATION THROUGH THE TARSO-METATARSAL JOINTS (Figs. 465-468).

This, though usually spoken of as Hey's or Lisfranc's amputation, includes, accurately speaking, the following **operations**:

1. **Lisfranc's**.—Amputation by disarticulation through all the joints.
2. **Hey's**.—This is usually described as amputation here by sawing through the bases of the metatarsals. In reality, Hey seems to have

FIG. 465.



Lisfranc's amputation. (Mac Cormac.)

disarticulated through the outer four joints, and sawn off the projecting internal cuneiform (*Observations in Surgery*, third edition, p. 552). 3. **Skey's**.—Disarticulation through the outer three and the first joints, the second metatarsal being sawn through (*Oper. Surg.*, p. 406).

Indications.—Few. (1) Limited crushes in which the sole is sound. (2) Disease limited to the front of the foot. (3) Inveterate bunion, with persistent sinuses and recurrent attacks of cellulitis. (4) Perhaps perforating ulcer. (5) Some cases of frost-bite.

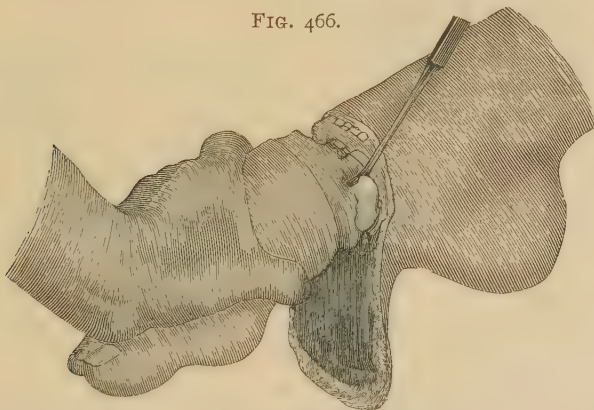
Owing to the complexity of the synovial membrane here (Fig. 457), any disease which has invaded the synovial membrane between the second and third metatarsals and the second and third cuneiforms, has also spread to that between the scaphoid and three cuneiforms. This, though of small moment in cases of injury, should put this amputation aside in most cases of disease.

Lisfranc's Amputation (Figs. 465 and 466).—The preliminaries are the same as in Chopart's amputation. The surgeon, standing to the right side of either foot, and so as easily to face the sole, places his left index and thumb on the bases of the little and great toe metatarsals respectively. The first of these can always be found by pressure, even if swelling is present; if there be any difficulty with the latter, it will be found a full inch in front of the readily detected tubercle of the scaphoid. These two points thus marked out are joined by a slightly curved dorsal incision with its convexity forwards. As a rule, if the tissues in the sole are sound, no dorsal flap should be made, the above incision being kept close to the line of the joints through which disarticulation is to be performed.

The foot being now flexed upwards, the surgeon, looking towards the sole, marks out a plantar flap by an incision running from the

outer extremity of the first cut (for the right foot) up the outer side of the foot, then across the heads of the metatarsals, and down the inner side, so as to join the inner extremity of the dorsal incision. This flap should be made a little longer on the inner than on the outer side of the foot, so as to cover the additionally projecting bones on this side. Its cut edge being taken firmly between the finger and thumb, the flap is then dissected up as thickly as possible—*i.e.*, containing all the tissues possible in the sole. In keeping the knife close to the bones some of the metatarso-phalangeal joints will probably be opened. Below these the flap, if steadily pulled upon, will, with light touches of the knife, readily separate from the metatarsal bones. The flap should be raised evenly, and without scoring or any button-holes. The prominent bases of the first and fifth metatarsals being laid bare, a few strong touches of the point of the knife may be required to separate part of the tibialis anticus and peroneus longus from the base of the former. The anterior part of the foot is now

FIG. 466.



Disarticulation of the second metatarsal in Lisfranc's amputation. The knife is being used, as described below, to separate the second from the first metatarsal bone.

strongly depressed so as to stretch the dorsal ligaments, and the knife, having been thoroughly carried round the base of the fifth metatarsal, is drawn obliquely forwards and inwards so as to open the joints of the outer three metatarsals with the cuboid and the external cuneiform. The joint between the first metatarsal and the internal cuneiform is next opened, and, lastly, the second metatarsal is freed as follows: The knife being held firmly in the fist, its point is inserted between the first two metatarsal bones, and the knife carried backwards and forwards in an antero-posterior direction in the long axis of the foot (Fig. 466). The same is then done between the second and third metatarsals, and, the lateral ligaments being thus divided, the joint between the second metatarsal and the middle cuneiform is found and opened,* this being facilitated by strongly depressing the

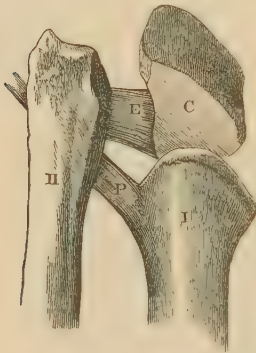
* The position of this joint must be remembered, and the way in which the base of the second metatarsal bone is locked in between its fellows and the cuneiform bones. Its base projects upwards between a third and a quarter of an inch above the others.

foot, care being taken not to do this so violently as to separate the second metatarsal from its upper epiphysis, or to fracture the bone.* A few remaining touches of the knife, aided by a twisting movement, will then suffice to separate the foot.

The method by disarticulation may be a useful test of a candidate's knowledge and skill at an examination. In practice, sawing through the metatarsals just below their bases may nearly always be substituted, as giving equally good results with a great saving of time and trouble. The truth of this I have personally tested.

This method of cutting the plantar flap before any attempt is made to disarticulate is strongly recommended in preference to disarticulating immediately after making the dorsal incision by passing the knife

FIG. 467.



C, Internal cuneiform. 1, First metatarsal. 2, Second metatarsal. E, Internal tarso-metatarsal interosseous ligament, passing between internal cuneiform and adjacent angle of second metatarsal. P, Peroneus longus. (Farabeuf.)

FIG. 468.



Stump after Lisfranc's amputation.
(Fergusson.)

behind the bones and cutting the flap from within outwards. In thus disarticulating before making the plantar flap, it is quite possible to puncture the tissues in the sole, and perhaps to wound the external plantar artery. Again, passing the knife behind the metatarsal bones often leads to a hitch, especially with the projecting fifth.

The dorsalis pedis and the external plantar artery are now secured with any smaller vessels which need it. Tendons are cut square, nerves shortened, drainage provided, and the plantar flap then brought up and secured in accurate position.

Owing to the thickness of the plantar flap and its tendency at first to unfold itself downwards, numerous points of suture, of sufficiently stout wire or silkworm-gut, must be made use of.

* While the surgeon is disarticulating the metatarsal bones the plantar flap must be held well out of the way to prevent its being punctured.

AMPUTATION OF THE TOES.

Practical Points.—(1) Any plantar scar is to be avoided. (2) The line of the metatarso-phalangeal joints lies a full inch further back than the inter-digital folds of the skin (Holden). (3) Partial amputations (save in the case of the great toe) are very seldom advisable, the stumps left being of little use, and inconvenient owing to their liability to project upwards.

AMPUTATION THROUGH THE PHALANGES OR THE INTERPHALANGEAL JOINTS.

These operations are not recommended, for the reasons just given. If a patient insist on having one performed, the directions already given for the fingers (p. 4, Vol. I.) will be found sufficient.

AMPUTATION OF ANY OF THE FOUR SMALLER TOES AT THE METATARSO-PHALANGEAL JOINTS.

This amputation is performed much as in the case of the fingers (p. 7, Vol. I.), but the following points must be remembered :

(1) The line of the joint lies a full inch above the web. (2) The head of the metatarsal bone is not here removed, so as to leave the supporting power of the foot undiminished. (3) It is most important to avoid, as far as possible, any scar on the sole.

The scar, a simple antero-posterior one, is well protected by the adjacent toes. The incision should always be begun on the dorsum, even in the case of the little toe, so as to avoid friction of the boots.

AMPUTATION OF GREAT TOE AT THE INTER-PHALANGEAL JOINT.

This is usually performed with a plantar flap, much as at p. 11, Vol. I.

AMPUTATION OF GREAT TOE AT THE METATARSO-PHALANGEAL JOINT (Fig. 469).

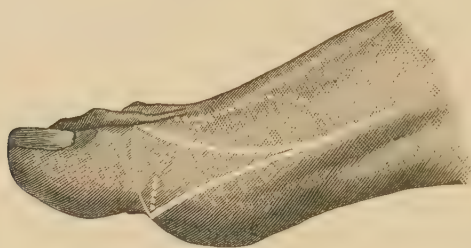
This is performed by the methods described at p. 7, Vol. I. The following points must be borne in mind :

(1) Owing to the large size of the head of the metatarsal bone, the flaps are often cut of insufficient length. The incision must be begun an inch and a quarter above the joint, and carried well on to the phalanx, one flap being cut longer than the other if needful. (2) The sesamoid bones must be left in connection with the head of the metatarsal bone, as any attempt to dissect them out is likely to imperil the vascularity of the flaps, especially after middle life.

In all other details the steps of this amputation are very similar to those already given at p. 7, Vol. I.

Though it is recommended by some excellent surgeons to remove the head of the metatarsal bone either transversely or obliquely from within outwards, this step, narrowing as it does the treading width of the foot, is not advisable, unless the condition of the skin is such as

FIG. 469.



Dorsal and internal flaps for amputation of the great toe and the head of its metatarsal. (Farabeuf.)

to render it impossible to obtain sufficient flaps to cover the entire head.

AMPUTATION OF THE GREAT TOE, TOGETHER WITH REMOVAL OF ITS METATARSAL BONE. (Figs. 472 and 473.)

This may be performed by a modification of the oval method as described for the fingers at p. 10, Vol. I.

OPERATIONS ON THE TOES AND METATARSALS OTHER THAN AMPUTATIONS.—HAMMER TOE, HALLUX VALGUS, AND FLEXUS.

Hammer Toe.—In cases requiring operation the choice lies between subcutaneous division of the resisting structures, excision of the joint, partial or complete, and amputation. Forceful rectification has not commended itself to me. The shortened skin will require division by a V-shaped incision, and cases needing this usually require more to be done.

Rectification by Subcutaneous operation.—The foot having been thoroughly sterilised, an assistant holds apart the adjacent toes; the surgeon, holding the toe at first flexed, enters a sharp-pointed tenotome to one side of the middle line of the plantar surface. Turning the edge towards the bone he severs first one and then the other lateral ligament and then the glenoid and long flexor. The toe is then brought into good position. If this cannot be effected, the skin may need division. This failing, the head of the first phalanx must be excised either by enlarging the wound on the plantar surface or by an incision on the dorsum.

Excision.—I consider this more certain than the operation above. A longitudinal incision is made to one side of the extensor tendon. This is carefully freed and drawn aside, the joint is opened and the head

of the first phalanx removed with sharp bone-forceps or a fine saw. If complete rectification is impossible any contracted structures must be divided, or, if needful, the base of the second phalanx removed.

After either operation the corn often present on the dorsum should be removed and, if needful, any hallux valgus operated on at the same time. Care should be taken not to apply the first dressing too tightly, or sloughing may occur.

FIG. 470.



FIG. 471.



Amputation of the little toe by a single dorsal and external flap. (Farabeuf.)

Amputation.—This is often described as needless and bad surgery as conducing to hallux valgus. I have frequently had it performed in hospital practice, and I only remember one case in which the patient returned with hallux valgus. Probably, had I seen to this condition being rectified at the time, this would not have occurred.

FIG. 472.



FIG. 473.



Amputation of great toe and its metatarsal bone by internal flaps. (Fergusson.)

The foot left by the operation. (Fergusson.)

Hallux Valgus.—Removal of a sufficient wedge from the metatarsal bone just behind the joint with a sharp chisel is the best operation here. This form of osteotomy gives better results than a linear one. Any contracted structures, *e.g.*, the extensor proprius hallucis should be divided at the same time. If it be preferred, the base of the first phalanx may be removed, but the head of the metatarsal should never be excised, owing to its importance as one of the supports of the foot. If much enlarged the bony projections may be removed.

Ingrowing toe-nail.—Operation is the best treatment of cases of any severity of this incorrectly named condition. Many methods have been described; the following is simple and efficient. It may be performed under local analgesia (Vol. I. p. 652) and the aid of an improvised tourniquet round the base of the toe. If, as is usually the case, an ulcerated and infected condition of the soft parts be present, this must be first dealt with by the use of boracic acid or dilute formalin fomentations, pure carbolic acid, &c.

From a point at least a quarter of an inch above and a little to the outer side of the inner angle of the nail-fold, a curved incision is carried through sound skin to a corresponding point below the nail, to reach which the incision is curved outwards. From the starting point a straight incision is then made between these two points, directly forwards, through the nail and its bed. The included nail, skin, nail-bed and angles of the nail-fold are then completely excised. The edge of the skin, carefully dissected free if needful, is then brought into contact with the edge of the nail and there kept in position by circular strips of gauze not applied too tightly. The tourniquet is then removed and a larger dressing applied, if needful. The foot should be kept well elevated. The patient can, usually, get about in ten days, especially if a leg-rest is used at first. After-attention to well-fitting boots, and to cleanliness of the toes and the way in which the nails are regularly trimmed, must of course be enforced.

CHAPTER VIII.

OSTEOTOMY.

OSTEOTOMY OF THE FEMUR FOR ANKYLOSIS OF HIP-JOINT.—FOR GENU VALGUM.—OSTEOTOMY OF THE TIBIA.—OSTEOCLASIS AND MANUAL REDUCTION.

FOR ANKYLOSIS OF HIP-JOINT.

THIS includes **Adams' operation** of division of the neck of the femur and **Gant's operation** of division of the shaft of the femur just below the trochanters. The latter being much the simpler, and giving excellent results, will, I think, replace the former.

Indications.—Cases in which the hip-joint is permanently flexed and stiff, and the patient accordingly crippled, either from old hip disease, or from ankylosis after rheumatic fever, pyæmia, &c.; cases in which extension has failed, together with trials of straightening the limb with the aid of anæsthetics.

Adams' operation divides the neck of the femur subcutaneously within the capsule. It is best suited for those cases in which the neck remains unabsorbed, as in ankylosis after rheumatic fever, and, much more rarely, pyæmia. A long tenotome or a straight narrow bistoury is entered about one inch above the top of the great trochanter, and carried on the flat downwards and inwards over the anterior aspect of the neck (p. 898). The edge is then turned towards the bone, and, by cutting deliberately and freely on this, a passage is made for the saw. The knife being withdrawn, the excellent saw which bears Mr. Adams' name is passed along the wound made down to the neck of the bone, which is then sawn through. After sawing for about four or five minutes, the limb should become movable. If this is not the case, the section has been made, not through the neck itself, but through the junction of the neck and shaft. Where the surgeon remains in doubt he should remove the saw and convert his wound into an open one, and make sure of his path by means of a sterilised finger.

In order to bring down the limb completely, the contracted tendons of the adductor longus, sartorius, and perhaps the rectus, will probably require division. The operation should be conducted with strict aseptic precautions, especially in adults, as it is the skin on the inner side which is most likely to give trouble.

The limb is usually straightened at once, and put up with a long outside splint—*e.g.*, a Désault's—and a little morphia given if needful. Where owing to tension of the skin it is unwise to complete the rectification at once, this step must be deferred for a few days. The

hæmorrhage and ecchymosis are generally trifling in amount, and the wound heals quickly.

This operation gives good results, though, as stated below, I prefer Gant's, owing to its greater simplicity. For there is no doubt that if the bone is dense from previous inflammation, and if the section trenches upon the shaft instead of going through the neck only, the sawing may be very tedious. Thus, I have seen two cases in which this took over half an hour.

A case is mentioned in a report from a committee of the Belgian Academy of Medicine, in which a patient who had been submitted to Adams' operation insisted on getting up on the twentieth day. Hæmorrhage came on from the fragments wounding the femoral vessels or some large branch. The femoral was tied just below Poupart's ligament; the hæmorrhage ceased, but free incisions were required for suppuration. The patient ultimately recovered. The same committee reported a death from hæmorrhage, and one from purulent infiltration. No bad results have, as far as I am aware, followed in England.

Gant's operation.—Here the shaft of the femur is divided just below the trochanters.

Advantages.—The operation is a simpler one than that just given, as the shaft is more readily reached and divided than the neck. Furthermore, it is an operation of wider applicability, for it is suited to all cases, not only those in which a neck remains, but those more common cases of ankylosis after hip-disease, in which repair has taken place with partial displacement of the head, or what remains of it. The fact that in these cases there is next to no neck left to divide, makes them unsuited for Mr. Adams' operation. For some time after this operation a projection persists at the site of operation, but this deformity is of no importance in this region, and it diminishes with time.

A long tenotome or, better, a sharp-pointed, narrow, straight bistoury, is entered just below the great trochanter, and made to divide everything down to the bone as it is lodged upon the outer aspect of the anterior surface, and then drawn down over the outer surface of the shaft. As it is withdrawn, the wound is a little enlarged downwards. The saw or chisel is then introduced along the wound well down to the bone, and the outer two-thirds of this divided, the rest being effected by snapping the bone by lateral movements. With a little practice, especially with the safer saw, it is quite easy to divide the bone completely. The tendons mentioned above will probably require division.

In neither case is it any practical good to try and secure a false joint. In my experience the results here are very uncertain. Weight-extension from the first and the most energetic massage and gymnastics as soon as the wound is healed are required and, as a rule, the patients will not take their share of responsibility. In cases of bilateral ankylosis a sub-trochanteric osteotomy on one side, and excision of the head on the other will facilitate the patient's sitting. It must be remembered that after both forms of osteotomy relapses may follow unless the after-treatment, on the part of surgeon and patient, is sufficiently attended to.

OSTEOTOMY FOR GENU VALGUM (Figs. 474-476).

Under this heading the following operations will be described:—

- I. Division of the Shaft of the Femur from the Outer Side (Fig. 476).
 - II. Division of the Lower End of the Femur from the Inner Side, just above the Epiphysial Line (Macewen, Fig. 476).
 - III. Division of the Lower End of the Femur and the Upper End of the Tibia above and below their respective Epiphyses (Barwell).
- I. Division of the Shaft of the Femur from the Outer Side

FIG. 474.*



FIG. 475.*

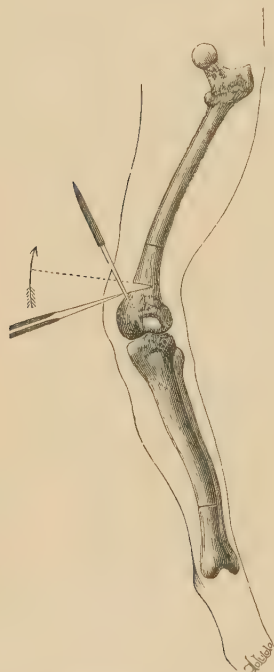


(Figs. 474-476).—The limb being supported, with the knee flexed, on a sand-bag, an incision about an inch and a half long is made at a right angle to and down to the bone on its outer side, about three inches above the external condyle. The knife—a narrow, straight bistoury—should go down to the bone deliberately, and cut firmly and strongly on it, enlarging the wound slightly as it emerges, in order that the soft parts may not be damaged if the heel of the saw is depressed, and that there may be no lip of tissues to hinder the escape of discharges. The saw or chisel is then introduced, and the bone divided for its outer two-thirds. As the thicker part of the bone is on the outer side, as

* Double genu valgum treated by division of the shaft of the femur from the outside. A good average case, both as to its severity and the results of operation. Some flat foot remains on the left side.

soon as this is divided the inner third usually gives way readily on carrying the knee and leg from without inwards. But the operator should continue the division of the bone till he can feel certain that two-thirds are divided, for if, after dividing only half, he tries, especially in the case of a dense bone, to fracture the rest and straighten the limb, either great or prolonged force must be made use of, leading

FIG. 476.



The transverse line on the shaft of the femur shows the site of division of the bone from the outer side. Below this are shown Macewen's and Ogston's operations, the second operation being now abandoned. The arrow indicates the direction in which the osteotome is worked in the former.† The line on the tibia shows the site of division of the bone for an ordinary rickety curve. This curve in the lower third should have been shown more marked. (After Barker.)

probably to irritation, cellulitis, and supuration; with, perhaps, necrosis; or the saw or chisel must be re-introduced, a point to be always avoided if possible, as the difficulty which is usually met with in hitting off the original track will be likely to lead to the above drawbacks.

The *advantages* of the above method are (1) that the femur is divided at a much narrower part than in the supra-condyloid operation of Macewen, and that thus it is more easily and quickly done. (2) The bone section is farther away from the epiphysis and the line of the synovial membrane, in case subsequent inflammation takes place. (3) There are no important blood-vessels near.

I readily admit that this operation has the fault, as is the case with sub-trochanteric osteotomy, of remedying one deformity by adding another. Its safety and efficiency lead me to recommend it where the operator is but rarely called upon to perform osteotomy.

II. Division of the Lower End of the Femur from the Inner Side, just above the Epiphysial Line (supra-condyloid of Macewen*) (Fig. 476).—The knee being flexed and supported firmly on a sand-pillow by the hands of an assistant grasping the middle of the thigh and leg, the skin resterilised, the position of the abductor magnus tendon and its tubercle are defined, and a longitudinal incision about an inch long (a little longer than the breadth of the chisel to be used) is made down to the bone at a point where the two following lines meet—viz., one drawn transversely a finger's-breadth above the upper margin of the external

* *Osteotomy*, p. 120.

† This is only safe in a child's femur; in an adult the osteotome is liable to be broken if pressed against the bone transversely to its breadth, and must only be worked in the direction of its breadth. This point, insisted upon by Sir W. Macewen, has been kindly pointed out to me by Mr. Cathcart.

condyle, and another drawn longitudinally about half an inch anterior to the adductor tubercle. The scalpel goes at once down to the bone. Superficial veins may be cut, but no artery normally distributed, as the incision is below and anterior to the anastomotica magna and above the superior internal articular. Before withdrawing the knife, the osteotome* is introduced by its side down to the bone in the same way as the knife—*i.e.*, parallel to the long axis of the limb—is then turned at a right angle to it, and the inner two-thirds cut through. *The direction of the bone-incision is most important.* The surgeon must cut transversely across the femur on a level with a line drawn half an inch above the top of the external condyle. This incision will avoid the epiphysis and synovial membrane. The line of the former may be usually represented by one crossing the femur at the level of the highest point of the femoral articulating surface, and running through or just below the adductor tubercle, so that, the incision being an inch above the tubercle, the epiphysis will be cleared. The only part of the synovial membrane which is as high as the bone incision is that under the quadriceps, which may reach in the adult as high as two inches above the trochlear surface. There is generally a quantity of fat between it and the bone. The spot selected by Sir W. Macewen for his incision is posterior to this point. As in a valgous limb the whole internal condyle is lowered, a line drawn transversely from the adductor tubercle might land the operator low down in the external condyle. The osteotome, placed against the inner edge of the bone, must be driven at first from behind forwards and to the outer side; it is then made to move forwards along the inner border until it comes to the anterior surface, when it is directed from before backwards and towards the outer posterior angle of the femur. By keeping on these lines there is no fear of injuring the artery. The hard external surface usually resists the osteotome, especially in adults, but the surgeon will soon recognise by touch or sound when his osteotome† meets this layer. It is the inner border and the anterior aspect of the bone which it is essential to divide thoroughly if the reintroduction of the instrument with the difficulties of ensuring its entering the old groove, and the risks of infection are to be avoided. If it be thought desirable to penetrate the outer dense part, it must be done very steadily, so as to check any undue impetus on the part of the osteotome. A sterile pad having been secured over the wound, the surgeon, pressing the thigh down on the table with his left hand, and taking the limb low down with his right, gives it a quick jerk outwards, this being repeated if needful. If it be necessary to reinsert the osteotome, care must be taken to get it into the groove again, and to use it coolly and methodically in accordance with the above given directions.

Mr. Keetley thus writes (*Orthopædic Surg.*, p. 33) on “cases in which the surgeon has almost entirely failed to get the improvement possible

* In adults a second, or even a third, finer instrument may be used, being slipped in over the first as this is withdrawn. In children one instrument will suffice.

† The osteotomes must be bevelled on both sides, wedge-like, and sufficiently trustworthy for hardness and toughness, points only to be secured by getting them of first-rate and painstaking makers. Sir W. Macewen's test is as follows: If the instrument will neither turn nor chip in penetrating the thigh-bone of an ox, it is well suited for cutting human bones. Its edge should be sharp enough to pare easily the finger-nail (Keetley).

from the operation. Such cases are often supposed to be cases of recurrence, but they are really only examples of bad management. The points to attend to are—(1) Correct the deformity while the limb is in a position of extreme extension at the knee. The slightest flexion of the joint hides the deformity and deludes the surgeon into a false sense of satisfaction. (2) The exact amount of looseness of the knee-joint, if any, should be noted before the bone is divided, and allowed for in putting up the limb. To this end the adjustment will sometimes have to be a position of distinct varum. (3) A certain amount of spring in the bones and extensibility in the ligaments, especially in the case of children, must be allowed for in the same way."

Division of the Internal Condyle Obliquely (Ogston, *Edin. Med. Journ.*, March, 1877 (Fig. 476).—This operation, though a great improvement on the operations which preceded it—viz., opening the joint and sawing off the internal condyle—has been entirely replaced by others—viz., Macewen's, and division of the shaft from the outer side. The free opening of the joint, with its great risks if the wound becomes infected, and the stiffness in any case have led to this. It will, therefore, not be described here.

III. Division of Tibia as well as Femur.—The division of the tibia (and the fibula also) as well as the femur has been advocated by Mr. Barwell and others. In the majority of cases, though, at first sight, there may seem to be one striking curve localised to one spot, a closer examination shows that in reality several curves are present, and often of different kinds, antero-posterior as well as lateral, diffused over the whole shaft rather than limited to one end. In these cases, rectifying one curve often makes the others more prominent. Multiple osteotomies are required here, the femur and the tibia each requiring division in two places. In one very aggravated case of genu varum, in which the limbs (when the ankles were placed together) formed a circle, Sir W. Macewen performed ten osteotomies at one time (*loc. supra cit.*, Figs. 40 and 41). In such severer cases most operators will prefer to straighten one side at a time.

Operation.—An incision is made as at p. 1069 over the inner surface of the tibia just below its tubercle, and the bone divided with an osteotome or saw from within outwards. The tissue on the anterior part just below the tubercle is much the densest. The division is commenced at the posterior part of the tibia and made, at first from behind forwards, and then from before backwards. The section of the tibia should be made on the same occasion as that of the femur.

However an osteotomy wound is made, whether with saw or chisel, no attempt should be made to close it. It is very rarely needful to remove the dressings before the tenth or fourteenth day. If a stain come through, it should be dusted with iodoform and a little fresh dry dressing applied.

Sir W. Macewen uses a splint consisting of a long outside, and a short back, with a foot-piece.* I have usually preferred plaster of Paris, applied by Mr. Croft's method, for children, amongst whom my experience has mainly lain. It makes even, steady pressure upon the muscles

* Sir W. Macewen advises the use of a mattress consisting of four parts, the two centre pieces corresponding to the glutæal region, and easily removed to admit of the introduction of the bed-pan.

around the wound, keeping them and it at rest, and it allows the patient to be more easily moved, especially when both limbs have been operated on. The outer piece of flannel should be brought high up, to the level of the iliac crest, so as to better command the muscles which disturb the upper fragment. In all cases of osteotomy, a long outside splint should be applied at first. However the limb is put up, the bandages must be applied firmly and evenly, but without undue tightness. The condition of the toes, as to colour and movement, must be carefully watched. When the dressings are removed at the end of ten or fourteen days I like to have an anæsthetic given, and to rectify any slight remaining deformity.

The splints or plaster of Paris should be continued for six weeks, when the limb may be only supported with sand-bags if the union is firm. Passive and active movement may be now allowed. In about three months the patient may be got up, with a stick, under observation. From an early date, care should be taken that he can bend his knee well.

Cuneiform Division of the Femur.—In cases where the curve is chiefly an antero-posterior one affecting the middle of the shaft, the deformity can only be properly removed by taking out a wedge. This is done on the lines given above. An incision is made through skin and quadriceps down to the periosteum, and a second firm cut exposes the bone. The divided muscles are then drawn aside with Spencer Wells's forceps applied to bleeding points, and the periosteum separated on each side down to the *linea aspera*. A wedge is then removed and the bone straightened. The bleeding is often free from the nutrient artery, but this is arrested when the bone is straightened. The greatest care must be taken to keep within the periosteum, the soft parts being thus uninjured, and to adopt strict aseptic precautions.

GENU VARUM.

As the tibia is usually the bone which is most at fault, the directions for its osteotomy given below will suffice. When the femur is also much concerned it must be divided by means analogous to those given for genu valgum. And, as in this condition if the lower third of the tibia be also curved, osteotomy of this bone and the fibula (*vide infra*) will be required. Division in two places may be necessary.

OSTEOTOMY OF THE TIBIA.

This may be (A) **Simple Division** or (B) **Cuneiform**—*i.e.*, the taking out of a wedge of bone. The former of these, a very simple operation, will suffice for the ordinarily curved tibiæ, where the bone is bent laterally, and the bend is most marked at the junction of the middle and lower thirds. Cuneiform osteotomy will be required when the bending is not only lateral, but antero-posterior as well.

A. Simple Osteotomy of the Tibia (Fig. 476).—The parts being sterilised, and the limb resting on its outer side on a firm sand-pillow, the surgeon notes, at the anterior and inner margins of the tibia, the spot where the curve is sharpest. Fixing his left index over the inner margin, he enters a long tenotome or narrow bistoury exactly over the

crest of the tibia, sends it down under the skin over the inner surface of the bone till its point is felt just beneath the finger; it is here pushed through the skin to make a counter-puncture for drainage. The knife, hitherto held horizontally, is now turned vertically and cuts firmly on the bone, dividing the periosteum, thick in these cases, in one line right across the inner surface of the tibia. As the knife is withdrawn it is made to enlarge the wound of entrance slightly, to make room for the saw. This (Adams') is now introduced in the same way as the knife, carried horizontally down to, but not through, the puncture through the skin of the inner border of the tibia. The left index keeping guard over the tibial artery, the saw is turned towards the bone and cuts through the inner two-thirds of it. The entrance of the saw into cancellous tissue can be known by the diminution of resistance and the increased bleeding which often occurs, but the best test of the depth to which the operator has arrived is the depth of the groove in which the saw has sunk. If it be preferred a sufficient wound is made, and a narrow osteotome employed. When the bone is divided sufficiently, a sterile pad is placed on the wound, and the surgeon, firmly placing his two hands, close together, immediately above and below the wound, sharply carries the lower fragment outwards. If the saw has been sufficiently used, the tibia snaps distinctly, while the fibula yields with a "greenstick" sensation. But if there be any difficulty here, this bone must be divided through a second incision. Great care must be taken to exert the force just on the sawn portion, or the ligaments of the ankle or the superior tibio-fibular joint may be strained and damaged. Attention has already been drawn to the need of using the saw sufficiently, otherwise the parts will be bruised and damaged in the futile attempts at fracture.

B. Cuneiform Division of the Tibia.—Removal of a Wedge.—

I have not found the plan of estimating the size of the wedge to be removed by first making an outline on paper of much service. The parts being duly sterilised, an incision is made along the crest of the tibia equal to the base of the wedge which is going to be removed. It need not be longer, as the skin can be pulled up and down if needful. The periosteum is then divided cleanly, and separated from the tibia with curved scissors. This membrane being held out of the way with retractors, a wedge is next removed with an osteotome or a narrow and sharp chisel but little bevelled. The gap can then be enlarged by removing from either side further slices as required. Occasionally free hæmorrhage takes place from the medullary artery, but this soon stops with firm pressure. The limb is now straightened by bending the lower fragment upwards* so as to bring the surfaces of the gap in contact. Difficulties which may be met with now are usually due to the wedge removed being inadequate in size or in shape. A sharp pair of bone-forceps may now be useful. The resistance of the periosteum at the back, or of the tendo Achillis are also factors. The former may require the removal of more bone, the latter division. The periosteum at the upper and lower angles of the wound may be closed with sterile sutures cut short. The skin wound is also closed above and below,

* Aided by movements in the opposite direction, and from side to side if needed. The fibula should always in these cases be also divided to secure exactitude.

but left open in the centre for drainage. In this and the preceding operation sufficiently thick dressings should be applied to meet any oozing from the bone. Plaster of Paris (p. 1068) or back and side splints should be applied.

Causes of Death and Failure after Osteotomy.

1. Infective troubles.—Such a case will be found published in the *Clin. Soc. Trans.*, vol. xii. p. 27. It is too probable that other operators have not been so candid. 2. Carboluria.—A case of rapidly fatal carbolic intoxication after antiseptic osteotomy of the tibia will be found in the same *Transactions*, vol. xiv. p. 201. 3. Hæmorrhage.—At least one case has occurred of hæmorrhage from the femoral and one from the anastomotica after division of the femur. I have also heard of a case in which the posterior tibial was injured in osteotomy of the tibia. 4. Necrosis.

This occurred, twenty years ago, in one of my cases of osteotomy of the femur, a lad of 16. It was noticed that he took the anæsthetic (ether) very badly, and when the effects of this had passed off he was extremely restless and excited for forty minutes. To this I attribute the mischief that followed. Suppuration with a very unhealthy state of the wound, œdema, and cellulitis ensued, leading to necrosis. Eventually the lad recovered, but required a cork sole of two inches. The presence of a pre-systolic murmur perhaps accounted for the effects of the anæsthetic.

5. Division of the tibialis anticus tendon.

This occurred in an osteotomy of the tibia performed by one of my dressers, who forgot how close the tendon lies to the outer side of the crest. The cut ends were joined by chromic catgut, and the action of the muscle was, afterwards, unimpaired.

6. Non-union. I have never seen a case, but though extremely rare, its occasional occurrence (Little, *Trans. Med. Chir. Soc.*, 1891) should be a warning against needless removal of bone, and any neglect of strict asepsis.

Osteoclasia and Manual rectification.—I have never employed osteoclasia, believing osteotomy to be more precise and far simpler. Mr. Keetley's words (*Orthopædic Surg.*, p. 49) are, as usual, weighty ones. "I have not found the ultimate good in respect of obliteration of deformity equal, in the average, to what can be got from osteotomy." Those interested in this method should consult a paper by Mr. Grattan, of Cork (*Brit. Med. Journ.*, May 3, 1890). Manual rectification is a perfectly safe procedure if the bone be soft enough to admit of a fracture, not mere bending. In such cases it is a great aid in the use of appliances. But in my experience, after the age of four, so much force is required as to render this method inefficient and risky as well. In anterior or multiple curves it is inapplicable (R. W. Murray (*Brit. Med. Journ.*, Aug. 25, 1894). **Treatment of severe curvatures of the tibia by manual osteoclasia.**—Mr. Openshaw is of a different opinion; his technique is as follows (*Lancet*, March 4, 1905):—"With the child fully anæsthetised, the leg is encased in cotton-wool and bandaged. The child is then turned over so that the leg which is to be broken lies upon its outer side. A wedge-shaped block, seven inches by three inches at the base and six inches high, is used. The upper edge of this block is about one inch wide and four inches long and is covered with thick india-rubber. The block is put underneath the leg transversely at the centre of the curve. The operator with one hand

grasps firmly the foot, ankle and lower part of the tibia, and with the other hand the upper part of the tibia, the hands of the operator being two to three inches apart. With the block resting quite firmly upon a firm table, and the child's leg on the rubber-covered edge of the block, with a steady and increasing pressure, the bones are snapped across and the leg can then immediately and easily be made to assume a straight position. In a few instances the fibula can be heard to crack first, but in the majority the fibula is simply bent, and the tibia alone is broken." In some 40 cases thus operated on Mr. Openshaw has met with no untoward result. The limb is put up in two lateral well-padded splints, and the child sent home. It must be brought for inspection the next day, when a skiagraph can be taken. The child is able to walk in three or four weeks. It is necessary that the tibia should be actually fractured. The two legs are dealt with at different times. In Mr. Openshaw's opinion the leg of any child under ten can be dealt with in this manner. I only refer to *osteotomies performed in out-patient practice* to condemn them. In Mr. Keetley's words (*loc. supra cit.*, p. 1071) "whoever attempts to deal with these cases in the out-patient departments must not be surprised to find, sooner or later, something very foolish and unwarranted done by some patient out of control."

CHAPTER IX.

TENOTOMY.

TENOTOMY OF THE TENDONS ABOUT THE FOOT.—
SYNDESMOTOMY.—TENOTOMY OF THE HAMSTRING
TENDONS.—TENOTOMY OF THE STERNO-MASTOID.

TENOTOMY OF THE TENDONS ABOUT THE FOOT.

Division of Tibial Tendons.

While I prefer to divide these tendons, *e.g.*, in a case of talipes equinovarus together with other structures by a flap incision (p. 1046), conditions may arise calling for simpler methods.

Tibialis Anticus.—This is usually divided where it is crossing the ankle-joint from without inwards, a little above its insertion into the internal cuneiform. It has, here, the *dorsalis pedis* vessels on its outer side, but separated from it by the *extensor proprius hallucis*.

The surgeon usually stands on the opposite side of the leg to that of the tendon, either facing the trunk or with his back towards it, as is most convenient. The assistant stands opposite to him, grasping the foot with one hand and the leg with the other. The position of the tendon is made out by making it tense by abducting and flexing the foot. The surgeon then notes the position of the anterior tibial vessels, defines exactly the width of the tendon, and places the tip of his index finger exactly on the side of the tendon farthest from him. He then inserts the tenotomy knife vertically close to the tendon on the side nearest to him; sinks it lightly till he feels sure it is on a level lower than that of the tendon; then sends it horizontally across till he feels its point just under his index finger, and, having turned its edge upwards, finally, by a series of light levering or sawing movements, cuts through the tendon. The assistant relaxes the foot—*i.e.*, adducts and bends it upwards—when the knife is first introduced, but places it on the stretch at a signal from the surgeon. Finally, as soon as the completion of the creaking sound and the sudden snap denote the division of the tendon, the foot is again relaxed. A small pad of sterile gauze being at once applied, the foot is put up in the everted position. For this purpose nothing is, to my mind, so simple and efficient as a well-padded splint of the proper width, with two notches at its lower end, the upper end being just below the knee in infants, and the lower projecting two inches and a half below the foot. The splint is applied to the outer side, the leg being first rolled in a flannel bandage to prevent pressure-sores.

Tibialis Posticus.—It is usually recommended to divide this an inch

and a half or two inches above the internal malleolus.* The tendon is here separated from the posterior tibial vessels by the flexor longus digitorum.

The surgeon and his assistant occupying positions as above, the exact site of the tendon is defined, if possible, by abducting and bending down the foot. In fat infants it is often quite impossible to feel the tendon, and in these cases a spot midway between the anterior and internal borders of the leg will be the best guide, as denoting the inner margin of the tibia. The surgeon then introduces a sharp tenotome so as just to touch, if possible, the inner margin of the tibia, taking care to sink the blade sufficiently to open the sheath freely. This being done, a blunt tenotome is introduced through the same opening, and pushed under the tendon; the edge being then turned towards it, and the tibia used as a fulcrum, the tendon is severed, together with that of the flexor longus digitorum. The assistant first relaxes and then extends the tendon, as advised above.

If the artery be cut, as shown by the jetting hæmorrhage and the blanching of the foot, firm pressure must be applied, the foot being first banded. No eversion must be practised, but the foot put up in the faulty position for about a week.

Plantar Fascia.†—This may be divided just below its origin from the os calcis, or in advanced cases of talipes close to the transverse crease, which is here found in the sole. With regard to this fascia, the surgeon should not tie himself down to any fixed spot, but divide resisting bands whenever they are felt.

Syndesmotomy.—This term was introduced by Mr. R. W. Parker (*Congenital Club-foot*, p. 62 *et passim*), who believes that in many cases—*e.g.*, severe ones, cases not treated in early life, and in some relaxed cases—the foot cannot be rectified even by multiple tenotomy. He attributes this, not to adhesions, but to the faulty shortness, and unyielding nature of the ligaments. Chief amongst these, in equinovarus, are the ligaments about the astragalo-scapoid joint. “In these cases there is a capsule made up above and internally by a blending together of the superior astragalo-scapoid ligament with fibres from the anterior ligament, and the anterior portion of the deltoid ligament below with fibres from the inferior calcaneo-scapoid ligament. To these are united fibrous expansions of the tendons of the anterior and posterior tibial muscles; together they form an unyielding capsule of great strength, which is attached to the several bones, not in the usual manner, but in adaptation to their altered relative positions. This I would name the ‘astragalo-scapoid capsule.’” Mr. Parker gives directions for dividing this structure which can be made to combine division of the tibial tendons. While I consider this method superior to that just given, I much prefer that by a flap (p. 1046), by which the needful tendons, fascia and ligaments can, all, be divided together. In syndesmotomy it is more difficult to make sure of dividing the tibialis posticus.

The site chosen for this combined division of tendons and ligaments is a little below and anterior to the tip of the internal malleolus.‡ Other guides are the site of the astragalo-scapoid joint, and in older cases the transverse crease which, running down on to the sole, denotes the continued inversion of the foot. Two tenotomes are required, one of ordinary pattern, and one curved, somewhat sickle-shaped, and with a cutting blade about half an inch in length.

* The tendon is here rather farther from the artery, and the surgeon will be above the commencement of its synovial sheath, in which it traverses the internal annular ligament.

† Division of the palmar fascia is fully described at p. 28, Vol. I.

‡ Mr. Parker (*loc. supra cit.*, p. 78) shows that Velpeau and Syme pointed out the possibility of dividing the tendon of the tibialis posticus here.

The surgeon notes the position of the arteries, and the lines along which the tibial tendons are curving towards the internal cuneiform. Having marked, at the spot above given, the position of these tendons, he enters a sharp-pointed tenotome, the parts being relaxed, just above the posterior tibial artery, and pushes it outwards on to the dorsum to a spot just short of the dorsalis pedis artery, the knife travelling just beneath the skin to make a path for the next instrument, which does the work. The curved tenotome is then inserted under the skin, and pushed on, flat-wise, till its tip can be felt over the tibialis anticus; it is then turned blade downwards, the tibialis anticus is felt to give way, and, as the knife cuts on the subjacent bones and cartilages, the ligaments are felt to yield to it, while, as it is withdrawn, its edge divides the tibialis posticus.

Tendo Achillis.—This should be divided half an inch above its insertion in an infant, and an inch and a half in an adult.

The foot and leg being turned well over on to the outer side, and the tendon being relaxed by the assistant bending the foot downwards, the margins of the tendon are accurately defined. The knife is then introduced vertically close* to the inner side of the tendon till it reaches a sufficient depth to ensure being beneath it;† it is then pushed horizontally across under the tendon till it is felt under the skin by the left index finger, which accurately marks out the outer limit of the tendon; the blade is then turned towards the tendon, which being at the same time put on the stretch by bending up the foot, is divided by a series of levering movements of the handle. Creaking movements, followed by a sudden snap or thud, denote complete division, when the tendon is to be at once relaxed and the knife brought out horizontally.

The Peronei.—The peroneus longus and brevis occasionally require division. They may be divided simultaneously by entering a tenotome between them and the bone about two inches above the external malleolus. Immediately above this process they are more under cover of the bone. If divided below it, their synovial sheath would be opened; this is to be avoided in case of infection.

Date of rectification. In the case of the smaller tendons, and in the more common cases of tenotomy, *e.g.*, for congenital equinovarus, this should be immediate. Where the tendo Achillis has been divided, and in many cases of tenotomy for infantile paralysis, correction must be made more gradually. Whatever operation is performed, *over-correction* must be ensured during the first fortnight, owing to the certain tendency to relapse. For retaining appliances I prefer felt or poroplastic in children, or a notched splint, like a Dupuytren's (p. 1073). If plaster of Paris is employed it should be in a form that is removable as soon as possible, to allow of the needful daily movements of the joints, and rubbing. Thus, after about ten or fourteen days, the foot should be *daily* manipulated by the surgeon for a while; and, later on, several times daily by the mother or nurse, the surgeon seeing the case every few days. If such manipulations are daily persevered with, and the case kept under the surgeon's eye, expensive boots and other apparatus will not be needed in children. To allow of these manipulations being begun early over-correction is essential. Finally, if only

* So as to avoid the posterior tibial artery.

† Young operators often do not insert the knife sufficiently deep; they thus, when it is pushed across, get *into the tendon* instead of *beneath it*, and so divide it incompletely.

justice were done to the methods of tenotomy and division of ligaments and to ensuring early over-correction, we should hear little of severer methods.

TENOTOMY OF THE HAMSTRINGS.

The patient being rolled two-thirds on to his face, the surgeon stands on the same side as that on which lies the tendon to be divided, facing or turned from the trunk as is most convenient. An assistant stands opposite to him to relax and tighten the tendon.

Biceps.—The exact limits of the tendon being defined, the surgeon introduces a sharp knife close to the inner side of the biceps, so as to get between it and the external popliteal nerve, and having sunk it sufficiently to get beneath the tendon, pushes the knife outwards, horizontally, till it is felt beneath the skin under the left index, which marks the outer limit of the tendon. The edge being turned towards this, the tendon is extended by the assistant, and divided in the usual way. When this is done, the limb is flexed and the knife withdrawn horizontally.

When the tendon is cut, a cord often rises up close to it. This may be the nerve, and the knife must on no account be re-introduced.

On account of the close vicinity of this structure, and because, in cases of any duration, contracted bonds of fascia are also present, I much prefer the open method by a small flap made with every precaution. The wound is united afterwards with one or two horsehair sutures.

Semi-tendinosus and Semi-membranosus.—These tendons can be divided in the same way as the biceps. A contracted knee can generally be straightened after division of the biceps and semi-tendinosus. If it is needful to insert the knife more deeply so as to divide the semi-membranosus, it would be well to use a blunt-pointed tenotome, or to operate through an open incision.

In one case of a girl of 16, after I had divided the biceps and semi-tendinosus, I had dipped the point of the knife a little more to ensure division of the deeper and larger semi-membranosus. Most profuse hæmorrhage followed from the superior internal articular vessels. Firm padding and bandaging were applied, and the limb put up in the faulty position for four days. No recurrence of the bleeding took place.

TENOTOMY OF THE STERNO-MASTOID.

The **open method**, in which the muscle is divided by means of an angular incision along the anterior border of the sterno-mastoid and inner third of the clavicle is the best here as it allows of every step being seen, of avoiding abnormal vessels, and securing, not only complete division of the muscle, but also of any fascial bands.

If **punctures** are employed the two heads are best divided separately just above the clavicle. The muscle being made prominent, by one assistant manipulating the head and another depressing the shoulder, the surgeon, standing facing the patient on the side to be operated upon, defines the limits of the inner border of the sternal tendon, opens the fasciæ sufficiently freely here, and then, taking a blunt-pointed

tenotome, insinuates it horizontally behind and close to the tendon till it is felt just beneath his left index finger, which is placed at the outer margin; the edge is then turned towards the tendon, and divides it. It is withdrawn with the usual precautions. The clavicular tendon is divided in a similar way through another puncture.

Care must be taken to avoid the anterior jugular, which runs outwards under the muscle a little above the clavicle, and the external jugular, which lies at a varying level close to the outer border of the clavicular head. If a sharp tenotome were dipped too deeply, the internal jugular might also be wounded.

If any smart venous hæmorrhage occur, a pad of dry gauze should be firmly bandaged on.

Causes of Failure after Tenotomy.

1. Infective troubles. These usually arise from the use of dirty instruments which clean themselves at the patient's expense, or carelessness in operating through an open wound. 2. Incomplete division of the tendon. 3. Division of important structures—*e.g.*, the tibial arteries, the external popliteal nerve, the anterior or internal jugular veins. 4. Non-union of the tendon. 5. Mal-union of the tendon—*i.e.*, adhesions formed by it to adjacent structures, *e.g.*, its sheath or a bone. These are both extremely rare. 6. Breaking off the point of the tenotome, usually against a bone.

CHAPTER X.

OPERATIONS ON NERVES.

NERVE SUTURE.—NERVE STRETCHING.

NERVE SUTURE.

THIS may be required as a **primary** or **secondary operation**. The latter is accompanied with much more difficulty, owing to the greater retraction of the nerve ends, their bulbous or filiform extremities, their being often buried in scar tissue or matted by it to neighbouring parts—*e.g.*, tendons and fasciæ; to which must be added other unfavourable points—*e.g.*, the atrophy and fatty change in the muscles and the stiffness of the joints.

Primary Suture.*—As the mode of uniting nerves will be fully described under the head of secondary nerve suture, the more difficult proceeding, it need not be repeated here. It only remains to emphasise the importance of always resorting to it, and not trusting to spontaneous cure. Howell and Huber (*Journ. of Physiol.*, vol. xiii.) have collected 84 cases of primary nerve suture; 42 per cent. of these were successful, 40 per cent. were improved, and in the remaining 18 per cent. the operation failed. The results of secondary suture can never be so good as these.

The chief cause of failure here is infection of the wound. As in all cases operated on at short notice sterilisation may be incomplete. Irrigation with some dilute antiseptic should be employed; the wound should not be closely sutured at first, sufficient drainage should be employed, and a boracic acid fomentation frequently applied for the first few days, when the remaining sutures can be drawn together, and the usual dressings employed.

Secondary Suture.—The operation on the median or ulnar will be considered, as these are so commonly injured. The following steps must be remembered: (1) Finding the nerve ends. (2) Freeing and resecting them. (3) Passing the sutures, and bringing the ends into apposition. (4) Dressing the wound, and the after-treatment.

1. *Finding the Nerve Ends.*—With accurate anatomical knowledge this is easy. An Esmarch's bandage does not appear to be necessary, as the incision is made parallel with the vessels, and the use of one leads to oozing afterwards. Mr. Bowlby (*loc. infra cit.*, and Hunt. Lect., *Lancet*, July 16, 1887) thinks that the parts should be rendered

* Much information on the subject of primary and secondary suture will be found in the section on Suture of Tendons (p. 40, Vol. I.).

bloodless. If this course is adopted care must be taken to provide any needful drainage, and the bandage must, if possible, be applied sufficiently far from the wound not to interfere with pressing down the parts when the nerve ends are approximated. If this bandage is employed, the parts should be made absolutely evascular; careless application will only cause most annoying oozing. An incision, two to three inches long, being made over and parallel to the nerve ends, the deep fascia and any scar tissue are carefully divided and the ends found, the upper bulbous and the lower filamentous usually, and not always in a line with each other. If the distal end be very difficult to find owing to its filiform shape and its being embedded in scar tissue, the wound should be prolonged, the nerve found lower down, and traced up to the distal end. The ends are next freed from the adjacent parts, and cleared of cicatricial tissue.

2. *Resection of the Nerve Ends.*—This is best effected by *sharp* scissors, with one stroke, and without any bruising. If the nerve is held with forceps, these must hold the sheath only. In case of primary suture, jagged or frayed ends need only be pared sufficiently. In later cases there is much more difficulty. Supposing the upper bulbous end to be taken first, before this is pared the nerve should be carefully stretched,* so that dissecting-forceps or any other means of holding the nerve may inflict any necessary damage on parts that will be cut away. It is not necessary to cut away the whole of a bulb; removing the greater part will expose healthy nerve fibres. Mr. Bowlby (*Inj. and Dis. of Nerves*, p. 165) advises that the section of the upper end should be carried through the uppermost part of the bulb, close to the normal trunk. Not only will numerous young fibres be found here, but, as he points out, the tougher tissue of the bulb affords an excellent hold for the sutures. With regard to the lower end, Mr. Bowlby thinks that all that is needed is “to cut away the extreme end, which, being matted with fibrous tissue and compressed by the surrounding scar, is very likely to contain no nerve tubules. It is seldom necessary to remove as much as a quarter of an inch, and, however unhealthy the section may look, no good is ever to be gained by a further sacrifice.”†

3. *Passing the Sutures and bringing the Nerve Ends into Apposition.*—The suture should be of properly prepared sterilised silk or chromic gut. There has been much dispute as to whether they should be passed through the substance of the nerve itself or only through the sheath. Experience has shown that the former practice is not only harmless to the nerve, but is the method most generally applicable. Two at least should be then passed at a sufficient distance from the ends—viz., at least a quarter of an inch—otherwise, they will cut out when they are tightened. Additional ones in the sheath will remove some of the tension. Where there is much separation, several sutures should be

* An Esmarch's bandage, if applied, will be found in the way now, interfering, as it usually must, with the stretching of the nerve.

† As the whole length of the lower end is in the same condition of degeneration throughout, manifestly no good can be done by cutting off successive sections in the hope that the cut surface may look more healthy than that which is seen in the first section (Bowlby).

passed through part of the depth of the nerve, one suture thus taking off some of the tension from its fellows. Another method is to pass one suture completely through the nerve trunk at least a quarter of an inch from each cut end. When the sutures in the nerve itself have been tied, two or three more very fine ones may be placed in the sheath, where the nerve is large enough.

In cases of much separation, before any sutures are passed, and again before they are tied, the parts should be as much relaxed as possible, and the upper end brought down by pressing down the soft parts. Stretching the nerve has been already advised.

All hæmorrhage being scrupulously arrested, and drainage provided according to the amount of the disturbance of the parts, &c., the usual dressings are applied, and the limb placed on a well-padded splint in a position which will best retain the nerve ends in apposition with the least discomfort to the patient.

Amount of Nerve Tissue which may be Successfully Removed.—From half an inch to three-quarters of an inch is probably an average amount.

Causes of Failure.—1. Infection of the wound. 2. Wide separation of ends and subsequent tension. 3. Atrophy, bulbous enlargement and sclerosis of nerve ends, so marked as to require much trimming, and thus tending to wide separation. 4. Unnecessarily rough handling of the nerve ends.

Aids in Difficult Cases.—1. Previous stretching of the ends. 2. Approximation of the ends by position of the limb. 3. Using several sutures, which distribute the tension evenly. 4. The use of "stitches of support" (p. 48, Vol. I.). 5. Autoplastic operation with nerve-flaps. M. Letiévant advises to make a slit through the nerve with a narrow bistoury about one-fifth of an inch from the end; the knife being then carried upwards for an inch or an inch and a half, is made to cut to one side so as to make a flap. The same is then done with the lower end, and the two flaps, being turned towards each other, are united by their raw surfaces (Fig. 31, Vol. I.). Dr. C. A. Powers, of Denver (*Ann. of Surg.*, Nov. 1904, p. 641), from a collection of cases in which this method was used, concludes that of six (all doubtful ones being excluded) two were failures, and four partial or complete successes. 6. Gluck and Vanlair advise that the nerve ends, whether united or only placed as closely as possible in apposition, should be passed through and left in a decalcified bone-tube, so as to keep the uniting material and granulations in a straight line. 7. The substitution of threads of silk and catgut may be tried (p. 50, Vol. I.); and this may be combined with the last mentioned plan. 8. Scar tissue may be used as a bridge between the ends.

Thus, Mr. Pick (*Lancet*, 1892, vol. i. p. 693) in a case of secondary suture of the median nerve more than two years after the injury, found lying beside the upper cut end some organising inflammatory material. Dissecting this from the side of the nerve, and leaving it still attached to the lower end of the upper piece, he turned it down, and sutured it to the lower end of the nerve. When the patient was last seen the function of the nerve was in process of restoration.

9. Implanting one nerve trunk upon another. Dr. Powers (*loc. supra cit.*) gives abstracts of ten cases in which implantation or anastomosis

was employed; in five or six the results are encouraging. This method is indicated where nerve trunks run parallel, *e.g.*, in the forearm; in the case of the popliteals it has been much less satisfactory. Two noteworthy cases are quoted from Dumstreya (*Deut. Zeitsch. f. Chir.*, Bd. lxii. 1901-1902, s. 376).

In one of extensive destruction of the ulnar, Dumstreya implanted the peripheral portion of this nerve into a button-hole in the median and placed substitution threads of catgut between the same point in the median and the proximal portion of the ulnar. In three months there was a marked return of sensation, to a less degree of motion, and a diminution of the contraction. In a case quoted by Dumstreya, Sick and Senger thus dealt with a case of extensive destruction of the radial. The peripheral portion of the radial and the median nerves having been exposed by one incision, a flap was split from the median and carried under the muscles to the peripheral portion of the radial. For several months there was no improvement, but, in a year and a half, the paralysis had almost entirely disappeared. In other cases the central end of the injured nerve has been sutured into a parallel one, at one point, and, a little lower down, the peripheral end is implanted in like manner.

10. Perhaps the use of zigzag incisions made in the upper end (Fig. 32, Vol. I.). 11. Making use of nerve-grafts. Gluck has resected an inch and a half of the great sciatic in chickens, and replaced it by a bit of a rabbit's sciatic sutured in. The birds walked afterwards as well as those treated by direct suture. In man the results have, on the whole, been unsatisfactory.

Mr. Mayo Robson (*Clin. Soc. Trans.*, vol. xxii. p. 120) after the removal of a growth from the median nerve, leaving a gap of two inches and a half between the ends, successfully made use of a corresponding bit of the posterior tibial nerve from a limb which was amputated in the adjoining theatre.* The following conditions are rightly given as essential: First, the entire absence of tension; two inches and a half of nerve being employed to fill an interval of two inches and a quarter. Secondly, great care was observed in handling the nerve to be transplanted. Thirdly, the transplanted posterior tibial nerve was transferred immediately as living tissue into its new bed. Fourthly, only one fine catgut suture was employed at each end to fix the nerve. The same surgeon successfully used the spinal cord of a rabbit as a graft in the median nerve of a man (*Brit. Med. Journ.*, Oct. 31, 1896, p. 1312).

Mr. Damer Harrison, of Liverpool (*Clin. Soc. Trans.*, vol. xxv. p. 166), gives nine other cases of nerve-grafting. The nerves used were the sciatic of recently killed rabbits or kittens, and the median from a human arm. Of the ten cases, three are stated to have been perfectly successful, six partially successful, and only one a failure.

Mr. C. Heath made use of nerve-grafting, replacing a gap in the ulnar, due to removal of a sarcoma, by two and a half inches of the posterior tibial nerve from a limb just amputated (*Lancet*, 1893, vol. i. p. 1195). A fibro-sarcoma had been removed from the ulnar nerve. The graft was retained in position by two fine silk sutures at either end. About twenty minutes elapsed from the time at which the limb from which the nerve was taken was severed from the body and the time when the junction of the piece of nerve with the ulnar nerve was completed. The wound healed by first intention, but fourteen months later there was no restoration of function in the nerve.

Larger statistics are less favourable (Powers, *loc. supra cit.*; Peterson, *Amer. Journ. Med. Sci.*, 1889). Thus of 23 cases, according to Powers, the results were "good" in three, and "fair" in three. He concludes that this method should be discarded. In a case of extensive destruction of the external popliteal nerve he implanted, about

* In its brief transit the nerve was placed in a solution of carbolic acid (1 in 40).

two weeks later, the injury having healed, four inches of the great sciatic of a dog. The result seven years later was "a complete failure as regards motion, and this in the face of conditions which seemed to promise a good result. The ends of the implanted fragment were carefully approximated, the sutures suitable, wound healing was perfect, and the fragment stayed in."

The graft does not remain as nerve tissue, but merely acts as a conducting material for the growth of the new nerve fibrils, in the same way as strands of catgut may do.

12. In cases of injury to the musculo-spiral nerve, where the ends are too far apart to admit of their junction by suture, they have been successfully approximated by resecting sufficient of the humerus—Wheeler (*Lancet*, 1894, vol. i. p. 939), Mann (*ibid.*, 1893, vol. ii. p. 59). This procedure is always attended with the risk of non-union. The only cases in which it is clearly indicated are those in which the nerve injury is accompanied by such a condition of the bone or bones as a false joint, *e.g.*, in a case of Prof. Keen (Chipault's "Etat actuel de la chirurgie nerveuse," 1901-1903).

Period required for Repair.—The following appears to be a fact not sufficiently recognised. The period required for union after secondary nerve suture is very much longer than is usually supposed to be necessary, owing to the peripheral end being degenerated, the muscles atrophied, and the joints fixed. Complete restoration of function will often require from one to two years. A patient who leaves his surgeon apparently but little better for the operation may return at the end of the above time with great improvement in the function of the limb. But it is seldom or never possible to restore the function of the part absolutely (Bowlby, *Lancet*, July 26, 1902).

It is the condition of the muscles and joints which alone puts anything like a limit on the period at which secondary suture can be successfully practised.

The longer the interval* between the injury and the suture, the more perseveringly must friction, electricity, passive and active movement, and massage be made use of, and the more will patience be required by both patient and surgeon.

Modern Gunshot Injuries of Nerves.—Mr. G. H. Makins, C.B. (*Surgical Experiences in South Africa*, 1899-1900, p. 372) gives the following advice as to *operative treatment*. "Early interference was only warranted by positive knowledge that some source of irritation or pressure could be removed; thus a bone splinter, or a bullet, or part of one, particularly portions of mantles.

"In case of contusion, the expiration of three months is the earliest date at which operation should be taken into consideration. The two strongest indications for operations are (1) signs pointing to the secondary implication of the nerve in a cicatrix, especially when these are of such a nature as to indicate local tension, fixation or pressure; (2) the possibility of the irritation being the result of the presence of some foreign body; in such cases the X-rays will often give useful help.

* The longest of these with which I am acquainted is a case of M. Tillaux's in which fourteen years had elapsed between the injury to the median and its suture.

“ With regard to the early exploration of cases of traumatic neuralgia, it may be pointed out that when this was undertaken the results were, as a rule, very temporary. In many cases, either no macroscopic evidence of injury to the nerve was discovered, or a bulbous thickening was met with of such extent as to make excision inadvisable.

“ Even when complete section of the nerve was assured by the absence of any power of reaction to stimulation by electricity from above on the part of the muscles, operation was better not undertaken until cicatrization had reached a certain stage. If done earlier than the end of three weeks, the sutured spot became implicated in a hard cicatrix, and any advantage to be obtained by early interference was lost. When partial division of a trunk was determined, the same date was the most favourable one for exploration, the gap in the nerve being freshened and closed by suture. There is little doubt, however, that in some cases such injuries were recovered from spontaneously.”

The same authority thus advises in cases where the lesion to the nerve was of doubtful nature (*ibid.* p. 370). “ As favourable prognostic elements we may bear in mind low velocity on the part of the bullet, and with this a lesser degree of contiguity of the track to the nerve. The early return of sensation is a favourable sign, and in this relation the development of hyperæsthesia, whether preceded by anæsthesia or no, points to the maintenance of continuity of, and a moderate degree of damage to the nerve. The early return of sensation, even if modified in acuteness, was always a very hopeful sign; also the production of formication in the area of distribution of the nerve on manipulation of the injured spot.”

NERVE STRETCHING.

This operation, introduced into England in 1880, and much used in the immediately succeeding years, has fallen into abeyance, the clinical results having failed to come up to the expectations raised by the operation.

Indications.—Of the following list it is only in the first six that the operation can be considered justifiable. It is certainly so in cases of sciatica due to exposure to cold and wet, from the results in two cases in which I operated.

1. Neuralgiæ.—In all cases where previous treatment has failed, nerve stretching may be practised before division of, or removal of, part of a nerve. The conditions justifying this in facial neuralgia have been already given (p. 416, Vol. I.). 2. Sciatica.—Nerve stretching is especially indicated here in cases due to rheumatic inflammation of the nerve from exposure to cold and wet. Dr. J. P. Bramwell has published (*Brit. Med. Journ.*, June 19, 1880) five cases of this kind, in which much benefit followed stretching the great sciatic. The most suitable cases are those where the pain is limited to the distribution of the nerve. In patients no longer young, organic disease, *e.g.*, in the pelvis, and like causes must be carefully excluded. If the pain, after being distinctly benefited, reappears, it would be justifiable to stretch the nerve again by an incision lower down. The more definite is the

sensation of adhesions broken down at the time of the operation, the better is the prognosis. 3. Locomotor ataxy.—One or both great sciatics have been stretched with a view of improving the lightning pains, the involuntary jerkings of the lower limbs, and the gait.* While improvement for a varying period may be expected as far as the first two are concerned, the prospect of improving the ataxy is very doubtful. Furthermore, the slow healing of the wound in these cases must be borne in mind. 4. Spasmodic contractions of voluntary muscles.—Here the operation seems to have been followed by success, temporary at least, in a very large number of cases. Where the spasmodic affection is of traumatic origin—*e.g.*, where a limb, after a contusion, is at the same time contracted and the seat of spasmodic movements—stretching of the nerves concerned may be absolutely curative. Quite another class of case—*viz.*, stretching the facial for tic convulsif—has been considered at p. 416, Vol. I. 5. Reflex epilepsy.—Sir V. Horsley (*Dict. of Surg.*, vol. ii. p. 61) states that, in those cases of epilepsy where the attack is preceded by violent pains localised distinctly to different nerves, very marked relief (amounting to cure in several instances) has been obtained by stretching the nerve trunks thus indicated. 6. Anæsthesia of leprosy.—Lawrie, of Lahore, seems to have met with striking success, the 50 cases published being all successful. The late Dr. B. Rake (*Brit. Med. Journ.*, 1890, vol. ii. p. 953) advised repeated stretching of the great sciatic as preferable to amputation for the painful perforating ulcer of leprosy. 7. Infantile paralysis.—Sir V. Horsley (*loc. supra cit.*) states that in 1861 Dr. Bastian had the great sciatic nerve stretched to improve the nutrition in a limb the seat of the above disease. The effect was to markedly increase the temperature and colour of the part, and apparently improve the state of the tissues. The result, however, does not seem to have been such as to find imitators.

Operation.—The following remarks refer to the great sciatic only, the nerve which has been most frequently stretched.

The parts being sterilised, an incision about four inches long is made over the nerve in the centre of the back of the thigh, commencing about an inch and a half below the lower border of the glutæus maximus. The interval between the hamstrings being hit off, retractors are inserted, and the nerve found a little to the inner side of the biceps. The fatty tissue around it is then carefully incised till the white epineurium itself of the nerve is exposed. Unless there be evidence of effusion within, it is better not to open the sheath. The nerve, being most entirely separated from adjacent parts, is now stretched. The force with which this is accomplished must vary somewhat with different cases. Thus, in sciatica, the index finger,† sterilised, being hooked under the nerve, this should be raised well out of its bed in the

* In a case of Dr. Bastian's (*Brit. Med. Journ.*, July 2, 1881), the patient, in an advanced stage of ataxy, experienced so much relief from the stretching of one great sciatic, that he asked for an operation on the other side. An interesting paper by Dr. Cavafy, with 19 cases collected from different sources, will be found in the *Brit. Med. Journ.*, 1881, pp. 928, 973.

† In the case of smaller nerves a blunt hook would be employed,

hope of adhesions being felt to give way both at the part stretched and at a distance also.

Mr. Marshall (*Bradshawe Lecture*, p. 28) thought that in neuralgia the stretching should be performed both ways. In ataxy it is essential to stretch down from the body.

The nerve, being found to be loose and elongated, is replaced in its bed, any bleeding is attended to, drainage, if needful, provided, and the wound carefully closed. Aseptic precautions must be made use of throughout, and the limb kept quiet with a splint or sand-bags.

In cases of stretching for sciatica, gentle movements of the limb should be begun as soon as possible to prevent the re-formation of adhesions.

PART VI.

OPERATIONS ON THE VERTEBRAL COLUMN.



**SPINA BIFIDA.—LAMINECTOMY OR PARTIAL RESECTION
OF THE VERTEBRÆ.—TAPPING THE SPINAL THECA.
—SPINAL ANÆSTHESIA.**

SPINA BIFIDA.

Indications.—All operative treatment should, if possible, be postponed until the child is two years of age or older. The operation is then borne far better, as is shown by published results. Where, in younger children, rapid increase in the size of the swelling is, however, taking place, and leakage is threatening or has actually occurred, the methods of injection or tapping may be resorted to as palliative measures, although the results, with few exceptions, will be disappointing. Briefly, the smaller the swelling, the less the evidence of involvement of the spinal cord or nerves;* the more the overlying skin approaches to normal, the less the swelling shows signs of increase in size; and the older the child—the greater are the chances of cure. The greatest possible importance, therefore, attaches to the question of careful selection of cases to be submitted to operative interference.

Operations.—Simple tapping being merely palliative and any form of drainage, *e.g.*, with sterilised horsehair, being very liable to be followed by infective meningitis, especially if the coverings of the sac are thin and unhealthy, the only two methods before us are: 1. **Injection with Morton's Fluid.** 2. **Excision.**

1. **Injection with Morton's Fluid.**—The Clinical Society's Committee (*Trans.*, vol. xviii.) collected 71 cases treated by this method. Of these, 35 recovered, 27 died, 4 were relieved, and 5 unrelieved. In a letter to the Committee (dated May 11, 1885), Dr. Morton was able to refer to 50 cases thus treated. Of these, 41 appear to have been successful, and 9 unsuccessful. But it is obvious that these statistics are largely unreliable. It is not unfair to say that nearly every successful case has been at once reported, while scores of unsuccessful ones have never been heard of. Owing to the large number of successes

* Points which make it probable that nerve trunks or the cord, or both, are present in the sac, are paralysis of the sphincters or lower extremities, a large sessile tumour with a broad base, and the appearance of cord-like bands when the sac is thin enough to transmit light.

which attended the use of this method, it is the only one which was recommended by the Committee of the Clinical Society. In four of the cases in which I have employed this method while complete shrinking of the sac was secured in each, hydrocephalus eventually supervened. And where this is not the case, the later effects of pressure of the cicatricial tissue upon any nerves present must be remembered.

The parts having been sterilised, a syringe which will hold about two drachms of the iodo-glycerine solution* is chosen, and a fine trocar. The calibre of this must not be too fine for the thick fluid which has to pass through it. The puncture into the swelling should be made well at one side, obliquely through healthy skin, and not through the membranous sac-wall, the objects being to avoid wounding the cord or nerves, and also to diminish the risk of leakage of cerebro-spinal fluid. Unless the sac is very large it is probably better not to draw off much, if any, of the fluid from the sac on the first occasion. The position of the child during the injection has been a good deal dwelt upon, most recommending that it should be upon its back. The Clinical Society's Committee advise that the child should be upon its side. About a drachm of the fluid should be injected. Every care must be taken to prevent any continued escape of the cerebro-spinal fluid, now and later, it being clearly understood that any such leakage, which is most difficult to prevent, will lead to infective meningitis and death. When the needle is withdrawn the puncture should be pressed around it, and immediately painted with collodion and iodoform, a dressing of dry gauze being also secured with collodion. I prefer to give a little chloroform to prevent any crying and straining at the time. The child should be kept as quiet as possible afterwards, on its side, and an assistant should make sure, for the first hour at least, that no leaking is going on. Shrinking of the cyst, continuing steadily, shows that all is well. If the injection fail altogether, or only cause partial obliteration of the sac, it should be repeated at intervals of a week or ten days.

2. **Excision of the Sac.**†—This is the method which, in spite of certain grave dangers, promotes, on the whole, the best results in carefully selected cases. The dangers are, of course, the suddenness with which the fluid may escape, with grave resulting changes in the hydrostatic pressure and circulation in the cerebro-spinal system, shock from interference with important nerve filaments, and meningitis set up at the time or as the result of subsequent leakage.

A wise selection of cases is most difficult. It is only possible to advise in general terms. A condition of the overlying parts which renders it doubtful if asepsis can be secured to begin with, should forbid operation. Weak antiseptics are likely to be useless, and strong ones harmful; they may even inflict further damage on the closely adjacent nerve tissues. An advanced degree of paralysis present should contraindicate interference; it will, probably, be impossible to separate and

* The fluid is iodine, gr. x; iodide of potassium, 5j; glycerine, 5j.

† The Clinical Society's Committee collected 23 cases treated by excision of the sac. Of these 16 recovered, seven died. They point out that no mention of the contents of the sac is made in six cases; that nerves were certainly absent in 16 cases; and that in one, which was fatal, they were certainly present (*Trans.*, vol. xviii. p. 380).

return the nerves present in the walls of the sac, and what is the real value of the life which it is attempted to preserve? It will be remembered that this condition and the preceding one often coexist. Other severe malformations are also contra-indications. As I stated above, any operation should, when possible, be deferred till about the age of two years. The effects of the interference are better met, the parts are more easy to handle, and one source of infection, that from the usually closely adjacent anus is diminished. In the rare variety of meningocele such delay is especially indicated.

Operation.—If needful, the too rapid escape of fluid can be prevented by a preliminary tapping and attention to the position of the patient. Every precaution against shock must be taken before, during and after the operation, and this must be completed as quickly as is consistent with safety. The parts having been sterilised and arrangements made for keeping the head low prior to and during the opening of the sac, elliptical incisions are made through the skin on either side of and sufficiently far from the base to ensure if possible (α) sound skin and (β) sufficient skin to meet in the middle line after partial excision of the sac and removal of the fluid. Such incisions are always to be employed when the central skin is unsound and undermining will be required. In other cases a flap may be preferable. The skin is then dissected back on each side with great care so as to avoid, if possible, punctures of the membranes, until the laminæ are reached. It may now be found that the tumour is clearly a meningocele being attached by a pedicle, which may be quite slender. In such a case the interior of the pedicle is inspected, and if it contain no structures of importance, it should be surrounded with a purse-string ligature of fine kangaroo-tendon, and the sac beyond cut away.

If there is no pedicle the sac is now carefully opened, at first with a trocar so that the fluid is slowly withdrawn, and the effects on the cerebral centres noted. The opening is then enlarged, and the interior carefully examined. If no nerve structures are present, the redundant sac is then cut away with blunt-pointed scissors, and the edges brought together with a continuous sterilised suture. So far the operation has been simple and straightforward. We must now consider more difficult cases. Where the coverings are in great part thin and translucent, even when this condition extends to the margin of the swelling, if the coverings can be rendered aseptic they may be partly utilised to form the meningeal flaps, the adjoining skin being undermined and made to slide over the new meninges.

When on opening the sac nerve structures are seen within, that part of their course which lies in the sac must be carefully detached with blunt-pointed instruments, until they can be gently pushed through the opening that communicates with the spinal canal. In more difficult cases, incisions must be made with blunt-pointed scissors between portions of nervous structures, in order to set them free, or they must be returned with a part of the sac *en masse*. In cases where the presence of nerve structures difficult to detach is marked, the safest plan will be the last. Having opened and examined the sac, the surgeon cuts away any superfluous part that is safe, then detaches the remainder and returns it with the nerves which run in it, through the opening, into the canal. It is greatly to be desired that surgeons

should specify what nervous structures were present, and how they were dealt with. As a rule this has been most imperfectly done. Where it is plain that the sac and its contained nerves cannot be returned without sacrificing some of the latter, the surgeon should hold his hand and close the wound. However small the nerves may be, it is impossible to determine their importance. Their removal runs a decided risk of causing permanent paralysis, or of increasing that already present.

The nerve structures having been returned, the flaps of meninges and skin are sutured separately and not in one line. A precaution of Mr. Robson's (*Clin. Soc. Trans.*, vol. xviii. p. 211) should be followed here. The skin and meningeal flaps should be so cut that their lines of union, when sutures are applied, are not opposite. Thus, the flaps should be cut of unequal width, so as to bring, *e.g.*, the wider skin flap on the left side, and the wider meningeal one on the right. Another means of obtaining the same end is to suture the membranes transversely, and the skin longitudinally. In some cases periosteal grafts* or bones from freshly killed animals have been introduced with varying success, and are to be preferred to attempts to close the gap by fragments chiselled off from the laminæ or sacrum. Considering the tender age and feeble powers of these patients—infants, as a rule—it is certainly not worth while to prolong an operation, anæsthetic, &c., for this purpose. If, however, the patient is not an infant and the condition is good, and moreover if the gap in the spine is a large one, an attempt should be made to protect this by means of flaps of aponeurosis and muscle derived from the erector spinæ. Either one large flap may be raised and swung across so that the line of sutures is at the side, or two flaps may be used and united in such a manner that the line of sutures is not immediately beneath the skin sutures. The very lowest part of the meningeal and skin flaps may be left unsutured, but no drainage will be needed, and leakage is greatly to be deprecated. Sterilised pads having been placed on the wound, a sufficient thickness of salicylic wool is then applied, and bandaged with firm and even pressure. For the first few days the head should be kept low and the spine raised so as to prevent the tendency to leakage of cerebro-spinal fluid, and to take the tension off the sutures. Prof. A. Henle (v. Bergmann's *Syst. of Pract. Surg.* (Amer. Trans.), vol. ii. p. 662) advises strapping the child to a plaster of Paris cast of the anterior surface of the body, reaching from the neck to the feet. The hips and knees are partially flexed and the legs somewhat separated. Soiling of the dressings is thus prevented. The patient is raised for the purpose of feeding. A shield of silver, vulcanite, or thin sheet-lead should be worn later until the parts have thoroughly consolidated.

Causes of Failure after the Radical Cure of Spina Bifida.—

1. Leakage and infective meningitis. 2. Convulsions and rapid death. Mr. Clutton, who brought a successful case of Dr. Morton's treatment

* Dr. R. T. Hayes, of Rochester (N. Y.) introduced twenty grafts of periosteum from a freshly killed rabbit. Three months later the case was reported to be satisfactory, with a firm, hard, resistant covering. (*Med. Record*, June 16, 1883.) Messrs. Watson Cheyne, C.B. and Burghard (*Man. of Surg. Treat.*, Part iv. p. 301) advise the use of the scapula or skull bones of rabbits. "The scapula, divested of its muscles, forms a very satisfactory plate, and has succeeded in more than one instance."

before the Clinical Society (*Trans.*, vol. xvi. p. 34), mentioned another in which this treatment was immediately followed by fatal convulsions. The same proved fatal in about ten hours in a case under my care. Sir W. Bennett, during the same discussion, mentioned a case in which, owing to the child being indisposed at the time, he declined to operate. On its way home the child died of convulsions. He remarked that if he had used the injection, this would have been credited with the convulsions. 3. Paraplegia. This setting in after injection may be temporary or permanent. 4. Hydrocephalus. This also may make its appearance after the injection with iodo-glycerine or excision, as happened in a case of my own three weeks after the latter operation. The nerves here were few and small and easily detached with the adjacent sac into the canal. 5. After tapping or injection the swelling may progress unaltered.

LAMINECTOMY, OR PARTIAL RESECTION OF THE VERTEBRÆ.*

This rare operation may be referred to here under the following indications: A. *Cases of injury, i.e., Fractures and Dislocation.* B. *Penetrating wound of the canal.* C. *Gunshot Injuries.* D. *Cases of inflammatory disease—e.g., Pott's curvature.* E. *Cases of new growth.*

A. *Cases of Injury.*—Here the operation has been suggested by the analogous one performed on the skull, and the large amount of success which has followed it. But the analogy is, for several reasons, a deceptive one. Thus, owing to the small size of the cord, an injury which would only damage the brain slightly, almost inevitably destroys the structure of the cord throughout its thickness. Again, it must be remembered that a fragment of bone often inflicts injury upon the cord instantaneously, and that, in a moment, irremediable damage may be done, though all deformity may be absent. Further, the cord may be most severely damaged, though its theca shows no sign of injury.

Again, when the surgeon trephines the skull, he not only hopes that the damage is slight and of a removable nature, but he also believes that the only damage to the bones is that which lies close to his trephine and finger. But in the case of the spine we are faced by this dilemma: If the fracture has been from direct violence, and the spinous processes and laminae have been driven in, it is only too probable that when these are elevated the spinal cord, so limited in size, will be found too much damaged to profit by the operation. On the other hand, if the fracture has been caused by indirect violence, it is almost certain that the bodies of one or more vertebrae will have been crushed down, and a portion shot back into the canal.† In this case the fragment which has inflicted the injury, and which is keeping up the mischief, will be in front of the cord and out of reach, even if the cord were in a condition to be much benefited by its removal. A surgeon

* Laminectomy, like appendicectomy, is objectionable from its hybrid derivation, but as, like the above term, it is explicit, convenient, and already in general use, it will be used here. Partial resection of the vertebrae is the only term which is correct and sufficient. It is, however, too long and cumbrous for general use in these days of hurry.

† This is a very common condition, judging from museum specimens.

trephining the spine under these conditions would be like one who trephined the skull in order to remove depressed fragments of the vertex, when all the time a portion of the base of the skull was lying jammed into the under surface of the brain.

But it is not only in the damage, but in the violence of the fracture also that no analogy lies between the two cases. Fracture of the spine is usually due to indirect violence, as when the neck is broken by a fall on the head, or when the lower dorsal spine is fractured by a fall of a sack upon the shoulders. Even when the fracture is due to direct violence, it is of an entirely different nature to that for which the surgeon hopes to trephine successfully in the skull, and one far more likely to produce extensive and crushing damage—*e.g.*, the fall of coal or earth, or a fall from a height upon a projecting body.

Finally, permanent compression of the cord—compression that can be removed, as can fragments of the skull—is a very rare event.* Even where permanent compression is present laminectomy will do but little. The surgeon may find it possible to restore the lumen of the vertebral canal, but the cord has usually been crushed as well as compressed. Mischief, usually hopeless mischief, has been done, for it has been proved by experiments and otherwise that a crushed cord is incapable of regeneration.

It remains to be shown that trephining the spine is not only likely to be void of any good results, but that it also involves serious risks and entails additional dangers of its own. Thus, the conversion of a simple into a compound fracture, the formation of a large, deep, and more or less ragged wound, the risk of subsequent suppuration with free access to the sheath of the cord, the opening up of cancellous tissue with its various channels and exposure of these to possible suppuration—all these have, I admit, been lessened by the use of modern precautions. But the risk, though diminished, remains; the large amount of venous oozing tending to soak quickly through in this region can only be met by frequent dressing. And though it has been shown that in some of these cases the wound has healed quickly, and though no improvement has followed, the spinal column has not been fatally weakened by the removal of the laminae and spines, yet the weakening for a time must be considerable; and it must be remembered that by the removal of these structures the mobility of the fractured parts will be much increased, and when any attempt is made to vary the position of the patient in bed, there will be, for some time, a risk of disturbing the fragments and, thus, of inflicting further injury on the cord.

It will be seen from the above that my own opinion is averse to any surgical interference in cases of fractured spine, owing to the amount of damage to the cord being usually, from the first, irreparable. To quote other writers: Mr. Thorburn (*Surgery of the Spinal Cord*, 1889, p. 160; *Brit. Med. Journ.*, 1894, vol. i. p. 1348) comes to the same conclusion, but draws an important distinction between the cord and its nerves. This writer thus sums up the question of operative interference in fractures and dislocations of the spinal column (*loc. supra*

* J. Hutchinson, *Lond. Hosp. Rep.*; Thorburn, *loc. infra cit.* It will be noticed that permanent compression is a very different thing from irreparable injury. The latter is present, only too frequently.

cit.): "In compound fractures, operate. In fractures of the spinous processes and laminae, with injury to the cord, we also operate. In simple fractures and dislocations of the bodies of the vertebrae, if there is a reasonable probability that the injury is due to hæmorrhage,* operation is advisable, but in all other cases of this nature we cannot hope to do good save where the injury is below the level of the first lumbar vertebrae. In such cases laminectomy is an eminently valuable surgical procedure." Mr. Thorburn advocates surgical interference here on the following grounds: (1) "We may here expect a regeneration of the nerve roots, the physiological evidence being strongly in favour of such regeneration, and not against it, as in the case of the cord. (2) The absence of spontaneous recovery in such cases in itself indicates the presence of a mechanical obstacle, such as permanent compression by bone, blood-clot, or cicatrix, otherwise we should expect the roots of the cauda equina to recover, as other peripheral nerves after severe injuries." For my own part I should only be inclined to interfere where the following conditions are present: A history of a direct injury; mobility and displacement, laterally or downwards, of the spinous process; great local tenderness; the usual symptoms of swelling, &c.; and paraplegia less marked than usual.

Those, on the other hand, who advocate surgical interference do so on the following ground: Dr. J. W. White (*Ann. of Surg.*, July 1889) believes that fracture of the laminae and spinous processes, and therefore relievable pressure on the spinal cord, will not be found so rare as has been usually believed. I fear that the weight of pathological evidence is all the other way. Dr. Weeks (*Trans. Amer. Surg. Assoc.*, 1901, p. 319) considers that "the surgeon should perform laminectomy in every case, if the condition of the patient is such as to justify any operation, regarding the operation in the first instance as an exploratory one. The hope of restoration of function in those cases in which the cord is not irretrievably injured depends on the promptitude with which the cause of compression is removed; and, however small the number of cases in which benefit is to be looked for, I hold that even those few justify one in immediate operation. Laminectomy is not a difficult operation, since the soft parts are always found torn and quite detached from the bone, and the introduction of cutting instruments under the laminae is very easy from the displacement present."

One case only is given, a very interesting one, as far as it goes, as it occurred in a patient of 70, and the laminectomy exposed a fracture of the laminae of the third and fourth cervical vertebrae. Very few details are given of the patient's condition—the left upper and lower extremities appear to have been chiefly affected—or of the operation. Two and a half months later there was some improvement in the motion of the left arm and hand, the patient could walk short distances by being supported on either side, and the action of the bladder had become normal.

* Mr. Thorburn thinks that the following would be the most advisable steps in these very rare cases: A laminectomy at the seat of injury, and an endeavour to arrest the hæmorrhage and to give exit to the blood; this procedure being combined in the first instance with paracentesis of the meninges in the lumbar region after Quinke's method (*vide infra*), and this failing, a secondary laminectomy at the lower part of the spine.

Dr. J. C. Munro, *ibid.*, in the discussion on the above paper, stated that he had had 21 cases of laminectomy, but gave no further information whatever. Dr. Mixter and Dr. Chase, of Boston (*Ann. of Surg.*, 1904), also advocate operative interference. Two cases are given suggesting a total transverse lesion of the lower cervical cord. One patient died in about twelve months from cystitis and pyelo-nephritis. The other recovered sufficiently to again engage in business. The authors follow Dr. Walton (*Journ. of Ment. and Nerv. Dis.*, vol. xxix., 1902) in advocating laminectomy because there are no typical infallible symptoms from which it can be asserted that the cord is crushed beyond a certain degree of repair. While evidence of degeneration may persist after a laminectomy, the improvement which followed in the second case suggests that an "increased transmission of impulses takes place along the remaining scattered fibres; the analogue of which is found in the increase of functions occurring in the kidney after unilateral nephrectomy, showing the power of nature to accommodate herself to adverse conditions."

I remain of opinion that where a large number of cases of laminectomy, carefully reported, are placed before the profession, the balance of pathological evidence will be against operation. A few isolated cases in which a varying degree of recovery has followed may show that where the condition of the patient and the surroundings are favourable, interference in skilled hands with the object of exploration is justifiable. Beyond this we cannot go. Few will accept the statement of Dr. Weeks that in these cases "laminectomy is not a difficult operation." Even if the tearing of the soft parts facilitates, as he claims is always the case, the preliminary steps of the operation, such injury facilitates the introduction of infection, and, a little later, the difficulties in restoring irregularities of the vertebræ—I refer especially to their bodies—may be enormous. If operation be undertaken, it is clear that this should be as soon as the patient has recovered from the primary shock: if possible within the second twenty-four hours. While the Röntgen-rays, if available, should always be employed, their use is, often, unsatisfactory.

B. *Penetrating Wounds of the Spinal Cord.*—Mr. Thorburn (*loc. supra cit.*) shows that while the percentage of recovery is good as to life, complete recovery of function is uncommon, owing to the little power of recovery of function after a destructive lesion of the spinal cord in man, especially in adults. He would also regard as useless the operation of suture of the pia mater as proposed by Chipault, and points out that it may be harmful not only by necessitating manipulation of the injured cord, but also by confining effused blood and serum, and thus increasing the pressure upon those parts which have escaped section. With the nerve roots, on the other hand, which are capable of repair, operation and suture would be quite justifiable.

C. *Operative Interference in Injuries of the Column and Cord from Gunshot Injuries.*—G. H. Makins, C.B., our most recent authority (*Surgical Experiences in South Africa*, 1899—1900, p. 340), is very emphatic here. "In no form of spinal injury is this less often indicated, or less likely to be useful. It is useless in the cases of severe concussion, contusion, or medullary hæmorrhage which form such a very large proportion of those exhibiting total transverse lesion, and equally

unsuited to cases of partial lesion of the same character. Extra-medullary hæmorrhage can rarely be extensive enough to produce signs calling for the mechanical relief of pressure; the section of the cord cannot be remedied. In one case with signs of total transverse lesion, in which a laminectomy was performed, no apparent lesion was discovered, and this would frequently be the case, since the damage is parenchymatous."

Only three indications for operation exist. "(1) Excessive pain in the area above the paralysed segment; operation is here of doubtful practical use, except in so far as it relieves the immediate suffering of the patient. (2) An incomplete or recovering lesion, when such is accompanied by evidence furnished by the position of the wounds, pain and signs of irritation, of pressure from without, or possibly palpable displacement of parts of the vertebræ, that the spinal cord is encroached upon by fragments of bone. (3) Retention of the bullet, accompanied by similar signs to those detailed under (2).

"In both the latter cases the aid of the X-rays should be invoked before resorting to exploration.

"Operation, if decided upon, in either of the two latter circumstances, may be performed at any date up to six weeks; but if pressure be the actual source of trouble, it is obvious that the more promptly the operation is undertaken the better."

D. *Cases of Inflammatory Disease—e.g. Pott's Curvature.**—Interference here will be but very rarely called for, as we have abundant evidence that paralysis, even when of long duration, has a marked tendency to recovery, if the treatment by absolute rest in the recumbent position is vigorously enforced.† Where a sufficient trial of this has really failed, operative interference is justifiable if there be no evidence of tuberculous disease elsewhere or infected sinuses. Dr. De Forest Willard ("Tubercular Conditions of the Spine requiring Surgical and Mechanical

* Reference should be made, in addition to the writings quoted above, to the following: (1) In cases of injury, Macewen, *Brit. Med. Journ.*, 1888, vol. ii. p. 308; Keetley, *ibid.*, p. 421; Duncan, *Edin. Med. Journ.*, 1889, p. 830; E. Hart, a case of M. Péan's, *Brit. Med. Journ.*, 1889, vol. i. p. 672; H. W. Allingham, *ibid.*, p. 838; Chipault, *Gaz. des Hôp.*; *Arch. Gen. de Méd.*, 1890; *Rev. de Chir.*, 1890, 1891, and 1892; these papers are now embodied in Chipault's work on the Surgery of the Nervous System; Schede of Hamburg, *Ann. of Surg.*, 1892, vol. ii. p. 230; Wyeth, *ibid.*, August, 1894; Biddell, *Med. and Surg. Reporter*, March 30, 1895; Lejare, *Gaz. des Hôp.*, June 2, 1884; Arnison, *ibid.*, May, 1895. (2) In cases of Pott's curvatures, Macewen and Duncan (*loc. supra cit.*); Wright, *Lancet*, July 14, 1888; W. A. Lane, *Brit. Med. Journ.*, April 20, 1889; *Lancet*, July 5, 1890; Abbe, *New York Med. Journ.*, Nov. 24, 1888; Kraske, *Centr. f. Chir.*, 1890, Heft 25; Dr. S. Lloyd, of New York, *Ann. of Surg.*, 1892, vol. ii. p. 289; Bullard and Burrell, *Trans. Med. Orthop. Assoc.*, vol. ii. p. 241. Several of the above cases have been reported so soon after the operation that their value would be much increased by the authors giving later details. (3) In cases of new growths, Dr. Gower's and Sir V. Horsley's paper (*loc. supra cit.*) and the appended table. See also Dr. J. W. White's paper (*loc. supra cit.*), and his table of the most obvious diagnostic points, p. 32; Starr, "Tumour of the Spinal Cord," *Amer. Journ. Med. Soc.*, June, 1895; and Patnam and Collins Warren (*Amer. Journ. of Med. Sci.*, October, 1899).

† "Most of the 'cures' reported as results of laminectomy are merely examples of *post hoc, ergo propter hoc* reasoning. I have read the reports of many, and have little doubt about it. The exceptions include the cases in which laminectomy has led to the liberation of pus and the exposure and erosion of pre-vertebral foci" (Keetley, *Orthop. Surg.*, p. 476).

Relief" (*Ann. of Surg.*, October, 1905, p. 514)) thus sums up on this point: "Laminectomy for paraplegia is advisable only after long continued and patient treatment from one to two years, since the prognosis, especially in children, is favourable and good powers of locomotion may be confidently expected. The operation is justifiable in selected cases where loss of motion and sensation are progressively worse and the symptoms threaten life." The anatomical difficulties and risks of laminectomy are well given in this candid and practical paper.

Mr. Thorburn (*loc. supra cit.*) gives the following indications and contra-indications for operation. **Indications:** (1) "Assuming the prognosis to be thus favourable, we are never called upon to perform laminectomy save under certain special conditions. It will not be argued that the recovery after laminectomy is more complete than that produced by Nature, and experience shows that relapses also are only too common after operation. The indications which appear to me to point to the necessity for operations are then as follows: A steady increase in symptoms in spite of favourable conditions and treatment. The presence of symptoms which directly threaten life. Thus, in my second case, the secondary chest troubles were very grave.* Intractable cystitis would fall into this category, but it is by no means common, and we can hardly agree with those who hold that the condition is in itself incapable of spontaneous recovery.

"The persistence of symptoms, in spite of complete rest,† is the indication which has been most commonly adopted, but, as we have already seen, such symptoms may persist for very long periods and then yield to absolute rest. It is, however, not improbable that, in a few cases, cicatricial pachymeningitis, or rather peri-pachymeningitis, may remain after the original pressure-lesion has ceased to act, and may thus keep up paraplegia until the constricting tissue is removed.

"4. In posterior caries (that is, in caries of the arches of the vertebræ) operation is clearly indicated, as here we can readily both treat the paraplegia and remove the whole of the tuberculous tissue. Two cases of this nature are recorded by Abbe and by Chipault respectively, and both proved highly successful.

"5. In my fifth case, the existence of severe pain, which was rapidly exhausting the patient, was regarded as an indication for surgical interference.

* Dr. Parkin, of Hull, in a valuable paper (*Brit. Med. Journ.*, 1894, vol. ii. p. 700), illustrated by cases of laminectomy for spinal caries, mentions a case aged 9, admitted for cervical caries, cyanosis and bronchitis. As the condition became more critical, the sixth cervical spine was removed. The cord was found compressed and bent by a mass of bone and fibrous tissue, the remains of the fourth and fifth vertebræ. When the cord was freed, pulsation returned. Very great benefit followed on the operation, but the child died nearly three months after of tubercular meningitis, thought to be due to a caseating gland found at the necropsy. No evidence of caseation or recent caries was found in the vertebræ.

† Readers with careful and well-balanced minds will not fail to note on reading the accounts of many of these cases, published as successful cases of laminectomy for spinal caries, that many of them before being submitted to operation, had only been treated by rest for a few days or weeks, "the mother having full directions to keep the child in the same horizontal posture." In other cases, after a brief period of in-patient treatment, the children have been sent out in Sayre's jackets to attend as out-patients.

"6. Lastly, children as a rule yield better results than do adults, so that, other things being equal, childhood may also be regarded as an indication for operation.

"**Contra-indications.**—The presence of active tuberculous changes in other organs. Macewen holds that we should not operate when there is pyrexia, which is almost tantamount to saying that we should not operate in presence of active tuberculosis. If, however, the pyrexia were clearly due to cystitis, then we might regard it as an indication for, rather than against, interference. Again, general meningitis (although fortunately very rare) will at times obviously be present and will probably prove fatal whether we operate or not."

E. Cases of New Growth.—It is in the intra-dural variety of these, when the level of the growth can be correctly estimated, that laminectomy is most decisively indicated. Sir V. Horsley has here, as in so many other instances connected with the surgery of the central nervous system, operated with brilliant success (*Med.-Chir. Soc.*, vol. lxxi. p. 383).

The patient was one of Dr. Gowers', aged 42, and his chief symptoms were complete paralysis of the lower limbs and abdomen, the former being frequently flexed in clonic spasms, the pain accompanying these being extremely severe. There was loss of tactile sensibility as high as, and involving the distribution of, the fifth dorsal nerve. The bladder and rectum were completely paralysed. The growth proved to be an almond-shaped fibro-myxoma resting on the left lateral column, in which it had formed a deep bed, and adherent to the fourth dorsal nerve. The patient recovered perfectly, the report being continued up to a year after the operation.

A great deal of useful information may be obtained from a paper on this subject by Messrs. Putnam and Warren (*Amer. Journ. of Med. Sci.*, October, 1899). The authors give a *résumé* of 33 cases of spinal tumour treated by operation. Of these operations "seven led to recovery and 10 to more or less improvement, although only in five of these latter, amongst which our first case was included, was the improvement considerable or lasting."

On the other hand, 15 of the operations were fatal, so that the mortality was nearly 50 per cent., a fact not to be lost sight of when this operation is contemplated.

Dr. J. Collins (*Med. Rec.*, Dec. 6, 1902) gives abstracts of 70 cases of growths of the spinal cord collected from the literature of the preceding six years. Thirty of these were operated upon. The results were as follows: 12 were successful, 8 partially so, and 10 wholly unsuccessful. The operation was considered successful when followed by cessation of pain and recovery of motor power; partially successful when pain was relieved, motor power slightly restored, and the case ceased to progress; unsuccessful when followed by death. A report of 32 cases of growths of the spinal cord, which were operated upon, to which one is added, by F. Krause, is given in v. Bergmann's *Syst. of Pract. Surg.* (*Amer. Trans.*), vol. ii. p. 646. In 31 the growth was found; 18 or 54·5 per cent. recovered, or improved sufficiently to walk; 15 or 45·5 per cent. died. In one case the growth was not found because it was looked for too low down, in another case it was not recognised. One of the best recent papers is that by Dr. H. Cushing (*Ann. of Surg.*, June 1904), on a case of "intra-dural growth of the cervical meninges."

The history before and after the operation is most fully detailed. Summaries of 10 other cases of intra-dural growth successfully operated upon are also given. Dr. Harte, of Philadelphia, gives (*Ann. of Surg.*, October, 1905, p. 514) a full list of cases in which laminectomy was performed for intra-spinal "tumours." These are briefly but instructively analysed as to the nature of the condition found and the mortality. This he finds to be nearly 47 per cent. He holds that it should be capable of reduction to 30 per cent., but in neither of these estimates is allowance made for cases which have not been published.

Operation of Laminectomy.—The thick skin of this region must be sterilised as carefully as possible, especially in the cases of injury in which operation is undertaken at comparatively short notice. To meet this difficulty a step taken at the Breslau Hospital (v. Bergmann, *loc. supra cit.*) may be useful. After the incision in the skin is made the adjacent area is covered with boiled oil-silk, containing a slit the length of the wound, the margins of the oil-silk being stitched to the subcutaneous edges of the wound, and covered with towels changed from time to time. When this guard is securely *in situ*, the gloves and instruments are resterilised. Every precaution must be taken against shock before, during, and after the operation. As the patient must be placed, as far as is safe, in the prone position, pressure must be taken off the chest by the use of small pillows, and the operator must be prepared for the need of rolling over the patient from time to time, especially in those cases where the abdominal muscles are paralysed. A longitudinal* incision is made down to the spinous processes, with its centre opposite to the site of the supposed displacement or disease. The deep fascia having been divided a little to either side of the spines and also transversely at the upper and lower angles of the wound, the tendinous attachments of the muscles are cut from the spine, and the muscles completely detached from these processes, the laminæ, and from the transverse processes as far as is necessary, by the edge of a short, stout scalpel or a chisel, the spinous processes being used as a fulcrum. The use of a blunt instrument is more likely to lead to some sloughing, especially where the structures separated are largely tendinous. To prevent hæmorrhage, Spencer Wells's forceps are quickly applied to the chief points, and sterilised pads out of sterile saline solution at a temperature of 110° are tightly packed by retractors into the incision on one side of the spine, while the operation is proceeded with on the other. This will best meet the chief bleeding, which is very free for a time. Sterilised adrenalin (1—1000) should be at hand. Efficient compression will usually suffice. Any vessels that require it being tied, and the muscles held back with retractors, any remaining muscular tissue is scraped away and the periosteum reflected with a suitably curved elevator. In cases of tuberculous disease, where access is desired to the bodies of the vertebræ rather than to their posterior processes and the spinal canal, the operator may desire to make his

* A flap, with its base in the middle line or to one side, is recommended by some, but, not admitting of ready enlargement, can only be suitable to those cases where the nature and site of the lesion are exactly known.

attack postero-laterally through the transverse processes and pedicles rather than through the spines and laminæ. In these cases especially it will be well for the operator to refresh his memory by having the corresponding part of the column in a dry state, kept at hand by an assistant (Keetley). In the one case the spinal canal is skirted, in the other it is entered. But to obtain free access, it is often advisable to combine the two routes in tuberculous cases. Two or three spinous processes, if unfractured, are then cut off close to their bases with powerful bone-forceps with jaws at different angles. The laminæ may be next removed by spinal saws, aided by a trephine, or the opening made by this instrument may be enlarged, as in the skull, by bone-forceps. Sir V. Horsley has devised bone-forceps well adapted to working at the bottom of a deep, steep wound-cavity.* Dr. W. S. Bickham, in a very instructive article on the technique of operations on the vertebral column (*Ann. of Surg.*, March 1905), recommends strongly Doyen's saw for removal of the laminæ and spinous processes. This is a strong Hey's saw with an adjustable guard, and is illustrated in Vol. I. p. 377. The guard of the saw is set at 10 mm., which will give a sufficient cutting edge to pass completely through the laminæ at any portion of the spine, provided the section be made well within the laminæ proper, and at a right angle to their surface. It is usually impossible to complete the section of one side with the saw in one position, as the proximal end of the saw will not travel the full length of the wound satisfactorily. The surgeon must divide the upper part of the laminæ on both sides, sawing from below upwards, and then walk round the table and complete the sections by sawing in the reverse direction. The usual flat probe tests the depth of the section. Partial division of the laminæ above and below those to be removed is unavoidable, and harmless (Bickham). A chisel and mallet may be used along an already made saw-line, to complete the section; but even here the vibrations may be hurtful. Further, unless a groove is first made with a saw, the line of the chisel is liable to be irregular. When the lumen of the canal is narrowed, this instrument becomes a dangerous one. Where the arches and the dura may be adherent, the bone must be removed with great caution; "picked away piecemeal," Tubby (*Orthop. Surg.*, p. 74). In the case of fracture, any loose bone will of course be tested and removed by sequestrum-forceps. The supra- and intra- spinous ligaments and the ligamenta subflava are next divided with blunt-pointed scissors at the two ends of the wound and the isolated segment of bone and ligaments is then partly prised, partly dragged out. In cases of fracture-dislocation, attempts may be made by manipulation of the parts now exposed by the wound, combined with extension and rotation, to rectify the position. The dura mater, covered with peculiar vascular fat, is next exposed. At this stage, if the opening be too narrow, it must be enlarged with rongeur-forceps

* The surgeon should take the trouble to be provided with the necessary instruments. The ordinary saws and forceps are quite unfitted for removing the laminæ, and, in the case of the cervical spine, may, by prolonging the operation and pressing on the cord bring about a fatal result, as occurred in one case which came to my knowledge. Hæmorrhage from the bones should be arrested by packing applied as above, or (Harte, *loc. supra cit.*) by Horsley's wax.

and gouge. If the operation is to be completed in one sitting (p. 1101), the next step is usually to expose the cord and membranes. The latter are generally found covered by a varying amount of fatty tissue containing veins. This layer should be quickly divided, exactly in the middle line with sharp scissors, and the two halves packed to one side with pledgets of sterilised gauze to meet hæmorrhage. Irrigation with hot, sterile saline solution may also be tried. The dura mater is then examined. If no pulsation be present, compression or increased tension suggest themselves. Where it is needful to open the membranes in the case of a growth, or the presence of blood, or to inspect a damaged cord, this step is best effected by picking up the dura mater with two pairs of forceps (one of these is held by an assistant), and then dividing the dura-arachnoid between these with scissors. Opening the sub-dural and still more the sub-arachnoid space will of course increase the risk of infection from the escape of fluid, and is therefore not a step to be undertaken lightly. Thus the dura should only be opened when fluid such as blood is present within, when the condition of the cord requires investigation, when sufficient mischief is not found outside, or when an intra-dural growth exists. This step is especially to be avoided in tuberculous cases, from the risk of meningitis (Chipault). Cerebro-spinal fluid is carefully mopped away, and if the spine is horizontal and the head is lowered, the flow usually soon ceases. If needful, the flow must be arrested by a small pledget of gauze. Where the anterior surface of the cord or the posterior aspect of the body of the vertebræ needs investigation, it is possible by means of an aneurysm-needle to partially displace the cord. If during this step it is really needful to divide one or two nerve-roots, these should be subsequently united by suture.*

In a few cases the cord itself has been sutured like a divided nerve, the stitches taking up the membranes and the cord itself. Such cases are recorded by Dr. Harte and Dr. Stewart, and Dr. Estes (*Trans. Amer. Surg. Assoc.*, 1902, pp. 28, 44), and by Dr. Fowler (*Ann. of Surg.*, October, 1905, p. 507). In this case the careful report is continued up to two years after the injury. The results are encouraging, especially in two of the cases.

In cases of *caries*, dense scar tissue, granulation tissue, pus, or a tuberculous mass may present themselves when the dura mater is exposed. In some it will be sufficient to take away the diseased material, till pulsation of the cord reappears; in others the tougher leathery substance must be snipped away with scissors till the cord is exposed with a surface made as smooth as possible, and it is clear that, if not pulsating, it is not constricted. Any carious bone that is within reach will of course be removed by the sharp spoon. If, as is not unlikely, the mischief—*e.g.*, tuberculous *caries*, abscess and granulation tissue—lie in front, this must be got at, if possible, by drawing the cord from side to side with an aneurysm-needle, and cautious removal of part of the transverse processes and adjacent bones (p. 1098).

* Dr. Fowler stated (*loc. infra cit.*) that : "Spiller and Frazier found that after division of a posterior root in the dog, followed by immediate suture, regeneration occurs, and that regeneration into the cord does not occur."

When all diseased bone, granulation tissue, &c., has been removed with the sharp spoon, a small flushing gouge, or gauze mops, iodoform emulsion may be applied, and the greater part of the wound closed; drainage, preferably by means of gauze, should, however, be provided for twenty-four or forty-eight hours, as oozing may be considerable.

In the case of *growths* the intra-dural ones hitherto operated upon have been usually met with on the postero-lateral aspect of the cord. A capsule, more or less complete, is generally present. It is to be noted that even when the correct level has been exposed, growths of the cord are sometimes difficult of recognition.* Such a case has been alluded to at p. 1096. This fact is well illustrated by the case which forms the basis of Dr. H. Cushing's paper (*loc. supra cit.*). "Fluid escaped in considerable amount from the sub-dural space. The dura was then incised the full length allowed by the exposure, and on holding apart the edges of the membrane the thin transparent arachnoid bulged into the opening like a distended bubble.† This was pricked, and the fluid spurted from the opening in jets corresponding with the cardiac and respiratory rhythm. Not until the contents of the sub-arachnoid space were thus evacuated, and the transparent membrane had settled closely over the cord, was it apparent that there was some underlying abnormality. The arachnoid was then incised, and lying on the left side of the cord was seen an oval growth of dusky purplish colour." This, removed by "gentle manipulations" and "shelling out," proved to be a fibro-sarcoma. The patient made an excellent recovery, and, three months later, was able to return to his work. In this case to facilitate removal of the growth one posterior nerve-root was divided.‡ Where such a root is infiltrated it must be sacrificed.

Treatment of the Wound.—To wash away clots and check oozing, flushing with hot sterilised saline solution may be employed, or a solution of adrenalin made use of. From the extent and depth of the wound and the condition of the muscles, drainage by at least a strip of sterilised gauze is indicated. When the theca has been opened, the lowest portion of the incision should be left open, the rest being closed by a continuous suture of fine silk. The muscles are brought together with buried sutures of silk or catgut. In a few cases the hæmorrhage has been so severe as to necessitate packing the wound. Where there is much oozing the first dressings will require changing at the end of twelve hours, and subsequently, perhaps, once in two days. The skin should on these occasions be carefully resterilised. Efficient

* If no growth can be found in the region exposed, the surgeon should not hesitate to remove the spines of three, four or five of the vertebræ higher up. The chances of an error in diagnosis are much less than those of failing to find the tumour through timidity in exploration. Of course the extent of the operation must be governed largely by the condition of the patient; and, in case of collapse, the operation should be concluded after a day or two, if possible, when reaction has occurred (Harte, *Ann. of Surg.*, October, 1905).

† Dr. H. Cushing observes that it has several times been noticed in these cases that the meninges below the growth are greatly distended with fluid (chiefly sub-arachnoid) under an increased tension, the growth, as it were, acting as a cork to the spinal flask in which the fluid continuously accumulates.

‡ This was believed to be the seventh cervical. The loss of sensation which followed is described with the full detail which abounds in this excellent paper.

support should be supplied by sand-bags. A plaster of Paris jacket should be applied as soon as possible. The application of this at the first considerably prolongs the time of the patient being on the table, and where much oozing takes place, may interfere with this being efficiently dealt with. The necessity remains of after-attention to such conditions as cystitis, or the most successful operation will be brought to nought.

Causes of Failure and Death after Laminectomy.—Many of these will have been made clear by the above given details: (1) Shock. Here, as in the case of the brain, the question of completing the operation in a second stage will sometimes arise. As I have already stated (p. 1098), the failure of the surgeon to supply himself with proper instruments may lead to needless prolongation of the operation and pressure on the theca, which, especially in operations on the cervical region, may help to bring about a fatal result. (2) Hæmorrhage. This has been fully alluded to; the extra-dural plexus appears to be usually obliterated in cases of Pott's curvature. According to Chipault hæmorrhage is much most serious in the neck, since death has resulted three times from a lesion of the vertebral artery. (3) Respiratory trouble, partly due to the prolonged anæsthetic. In one case (Deaver, *Inter. Journ. Med. Sci.*, December, 1888) the respiration became much embarrassed towards the end of the operation; this, continuing till the patient's death three days later, was attributed to injury to the phrenic nerve with an exploring needle. The dura mater, thickened and adherent to the bones, had been thus explored after removal of the third and fourth cervical arches which were carious. (4) Infective complications. (5) Tuberculous or other secondary deposits elsewhere. (6) Temporary improvement followed by a relapse.

TAPPING THE SPINAL THECA.

The following are the chief indications for its employment. i. Pressure of the cerebro-spinal fluid on the nerve centres in hydrocephalus (Quinke), growths, and effused blood. In the case of growths of the brain temporary relief of headache has followed, but death has taken place suddenly in several cases, owing to the withdrawal of the fluid having allowed the growth to make pressure upon the medulla. In tuberculous meningitis it has been used as a means of diagnosis (Quinke). It has also lessened the headache; in the epidemic cerebro-spinal form puncture has occasionally withdrawn pus. ii. As a means of diagnosis in different forms of meningitis, serous, purulent and tuberculous* (Quinke). iii. In the treatment of tetanus. In my own mind this, together with intra-neural injections, is the most scientific and promising method of dealing with this terrible disease. American surgeons from their enormous experience† have shown the way here. The

* Fürbringer found tubercle bacilli in 27 out of 37 cases of tubercular meningitis, one of which is stated to have ended in recovery (*Berlin Clin. Woch.*, Nov. 13, 1893).

† Thus a leading article (*Journ. Amer. Med. Assoc.*, Aug. 29, 1903) shows that out of the casualties of the Fourth of July celebration of that year alone, 466 ended fatally. Four hundred and fifteen cases of tetanus occurred, and it is believed that this list is incomplete.

treatment must be early, and, in many cases, prophylactic. "It has been well said that a patient who is having tetanic symptoms is not beginning to have tetanus—he is beginning to die from it." The intra-spinal injection has been successful when accompanied by intra-neural ones into each of the trunks of the brachial plexus, each being repeated, the intra-neural one by reopening the incision made. It is well to try and scratch some of the nerves in the cauda equina (Rogers, *Journ. Amer. Med. Assoc.*, May 14, 1903). Any wound present should be thoroughly disinfected and drained. The experimental work of Marie, Meyer and others and the results prove this method to be more logical than intra-cerebral injection, simpler, and less dangerous.

Operation.—The interval between the third and fourth lumbar vertebræ may be found in thin patients by counting downwards from the twelfth dorsal vertebræ. In stout or muscular patients a line drawn between the highest points of the iliac crest usually traverses the upper edge of the fourth lumbar spine when the column is flexed. It is better, even in children, in order to secure the needful rigidity, to have a special needle 4 to 5 cm. long. In adults the length should be 8 to 9 cm. The above space having been marked with iodine and the sterilised skin steadied by the left index finger, the needle is introduced just outside the upper margin of the fourth lumbar spine, if the above space be selected. It should be directed a little upwards and towards the middle line. Slight resistance is felt as the point traverses the ligamentum subflavum. If it should be stopped by bone the point is, of course, withdrawn a little, and directed differently. Fluid is usually reached in children at a depth of 2 to 3 cm., in adults at about 4 to 7 cm.

When the fluid is being withdrawn to relieve tension, the operator must be guided by the pulse, any tendency to syncope,* or pain in the head.

Albertin (*Lyon. Méd.*, Oct. 8, 1899) reported a most interesting case, which serves to illustrate the usefulness of this measure in relieving intra-spinal pressure in certain cases:—

A man fell from a window, striking his knees and then his back. Paraplegia was the immediate result, the reflexes were absent, and there were large areas of cutaneous anæsthesia. The sphincters were, however, unaffected. Fourteen days later Albertin inserted a trocar into the spinal canal in the lumbar region, and drew off one ounce of blood-stained fluid. Forty-eight hours later the reflexes had returned, and from this time slow improvement took place, so that two weeks later the patient could walk with crutches. The final result is not given.

Spinal Anæsthesia.—This method, introduced by Dr. L. Corning, of New York, has had an extended trial in America, and is largely employed by French surgeons. It has never found favour in this country. While it is possible by its adoption to diminish shock (*vide infra*), it is clear that the method is not without difficulties and dangers, and is only likely to be used where the surroundings are especially favourable, as in a large hospital. The drug chiefly used has

* Showing that the puncture of the spinal membranes, not to mention the injection of cocaine, eucaine and stovaine, which is considered below, is not without risk, Gumprecht (*Deut. Med. Woch.*, 1900, Bd. xxvi. S. 386) reported 17 cases of sudden death following simple lumbar puncture for diagnostic purposes.

been, till recently, cocaine. Those interested in the subject will find much information in papers by Dr. W. White and Dr. Patterson (*Amer. Journ. Med. Sci.*, 1901, p. 227); Tuffier (*Presse Méd.*, Nov. 7, 1900), a report of 210 successful cases, 112 of which were intra-peritonæal operations. Dr. W. M. Perkins collected (*New Orleans Med. and Surg. Journ.*, September, 1902) 2,345 cases of spinal analgesia; of these 16 or 1 in 146 appear to have died from the use of this method. The most frequently used injection was 10 to 15 m. of a 2 per cent. solution of cocaine muriate, containing one-fifth to three-tenths of a grain of the drug. Analgesia usually begins in about ten minutes or less, and is complete up to the umbilicus in about twenty. Disagreeable nausea was present in about one-third of the cases and severe headache in a few. Temporary retention of urine and paraplegia have occurred. The most serious risks are infection, the dangers of cocaine itself, and the possibility of permanent injury to the cord. Like other modes of analgesia it is not suited to children or nervous patients, as a rule. The cases which chiefly call for the use of this method are abdominal ones, especially where peritonitis is present (*vide infra*), and some of amputation,* though in the latter the method of Crile (Vol. I. p. 226) by intra-neural injection, *e.g.*, in the lower extremity of the great sciatic and anterior crural, in order to diminish shock when a general anæsthetic is employed, or local analgesia (Vol. I. p. 652), in cases such as amputation for diabetic gangrene, will be preferred by most.

Quite recently (*Brit. Med. Journ.*, May 12, 1906) Mr. Dean has drawn attention to the value of intra-spinal analgesia with stovaine† in cases of acute general peritonitis. Three cases of operation in acute appendicitis, one for volvulus of the sigmoid, and two of castration are given. In five of the cases analgesia was most satisfactory. In the case of the volvulus grave failure of respiration set in while the volvulus was being reduced, and though the patient rallied from this, cardiac collapse followed from which the patient died nine hours after the operation. In such a case the result may well have been due to the effect of the volvulus and not to the drug. Mr. Dean considers that by intra-spinal analgesia with stovaine surgical shock is avoided, "patients having extensive wounds inflicted upon the abdominal wall with manipulation of inflamed viscera, and flushing of the peritonæal cavity seem little if at all affected."

Method.—The space between the third and fourth lumbar vertebræ is usually chosen (p. 1102). As there is a risk of producing an amount of intercostal paralysis sufficient to seriously hinder respiration, Mr. Dean advises that the drug be given by graduated dosage. "In these acute cases it is very difficult to estimate the amount that will be required to

* Dr. Gibbon (*Philad. Med. Journ.*, May 2, 1903) reports a case of painless amputation of the leg after the intra-spinal injection of cocaine. The patient suffered from tuberculous disease of the ankle, and a general anæsthetic was considered to be contra-indicated. The great sciatic and anterior crural were first exposed and injected by the infiltration method with a 1 per cent. solution. The amputation was painless and the patient made a good recovery.

† Stovaine is the chlor-hydrate of one of the amino-alcohols. "Its chief physiological difference from cocaine is that it is a vaso-dilator, not a vaso-constrictor, and, further, it seems to have a tonic effect on the heart" (Dean).

produce complete anæsthesia, and, owing to the danger-zone of intercostal paralysis being near the limit of the anæsthesia required, it is necessary to feel one's way. I consider that it is of paramount importance in cases in which the anæsthesia has to reach the level of the upper abdomen to commence with a minimal dose, and to gradually increase it if necessary. This means that it is necessary to keep the cannula in until the maximum effect has been produced. I commence with a dose of 0.6 ccm. as a minimum; and if at the end of seven minutes it is obvious that one dose is too small, an extra 0.3 ccm. should be given until the extent of the anæsthesia required is obtained. 'This is the only way at present to avoid the danger-zone of intercostal paralysis.'* To allow of the cannula being retained, and to prevent its being pressed upon, or disturbed during any movements, Mr. Dean has devised a flexible cannula which he considers possible to leave in position. Whatever syringe is used must meet the requirements of being easily sterilised, and of holding 3 to 4 ccm. of the solution.

* In the same periodical Dr. D. Mackenzie gives the following caution as to intra-spinal analgesia, the result of his experience of stovaine on mucous membranes such as those of the nose and throat. Having found that in one case a 10 per cent. solution left too long *in situ* caused superficial sloughing, he points out the need of observation as to any irritant effects arising after the operations under intra-spinal analgesia. "In the case of the spinal cord in particular care should be exercised, for, if the drug effects a destructive or irritant effect on mucous membranes, it stands to reason that a delicate nervous tissue may also suffer from an intimate contact with stovaine, even when it is used in very weak solution."

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